Jane's

MAJOR WARSHIPS

1997

Edited by David Miller

First Edition

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Volume One

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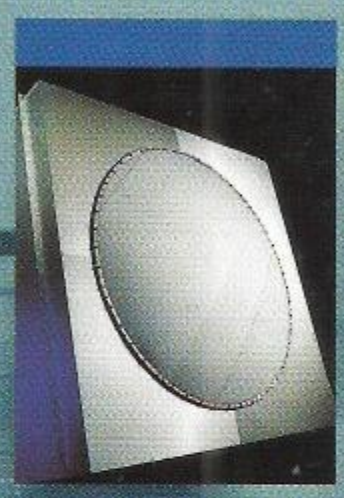

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Contents

Introduction		[9]
Glossary		[17]
Aircraft carriers (CVN/CV/CVG/CVS/CVSK)		2
Shipboard aircraft	— Helicopters	80
	Fixed-wing	123
Strategic submarines, ballistic missile, nuclear powered (SSBN)		151
Attack submarines, nuclear powered (SSN)		187
Attack submarines, diesel-electric powered (SSK)		253
Cruisers (CGN/CG)		457
Destroyers (DD)		507
Contractors List		765
Pennant List		769
Ships' Names and Classes Index		773
Sensors Index		777
Weapons and Aircraft Index		781

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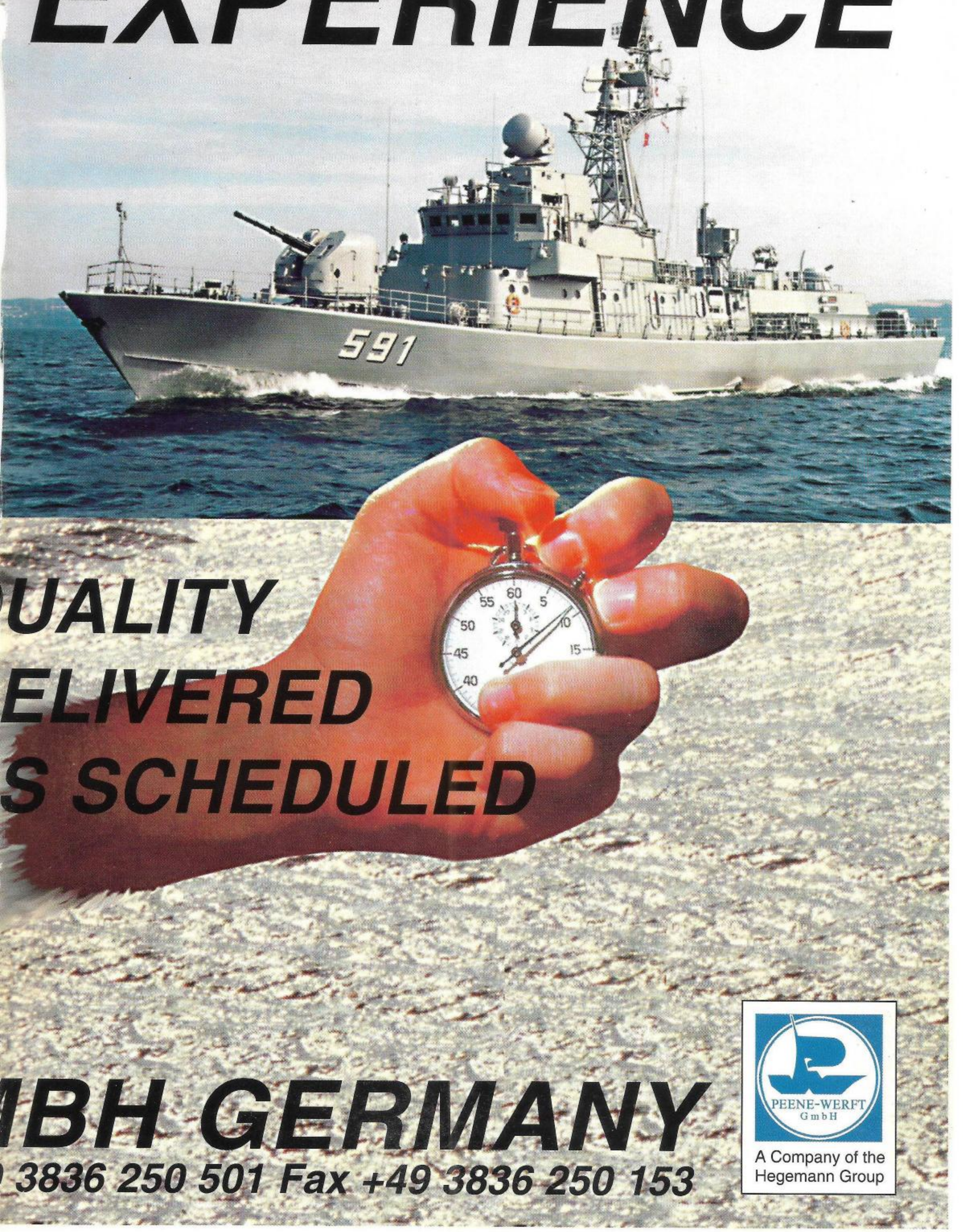

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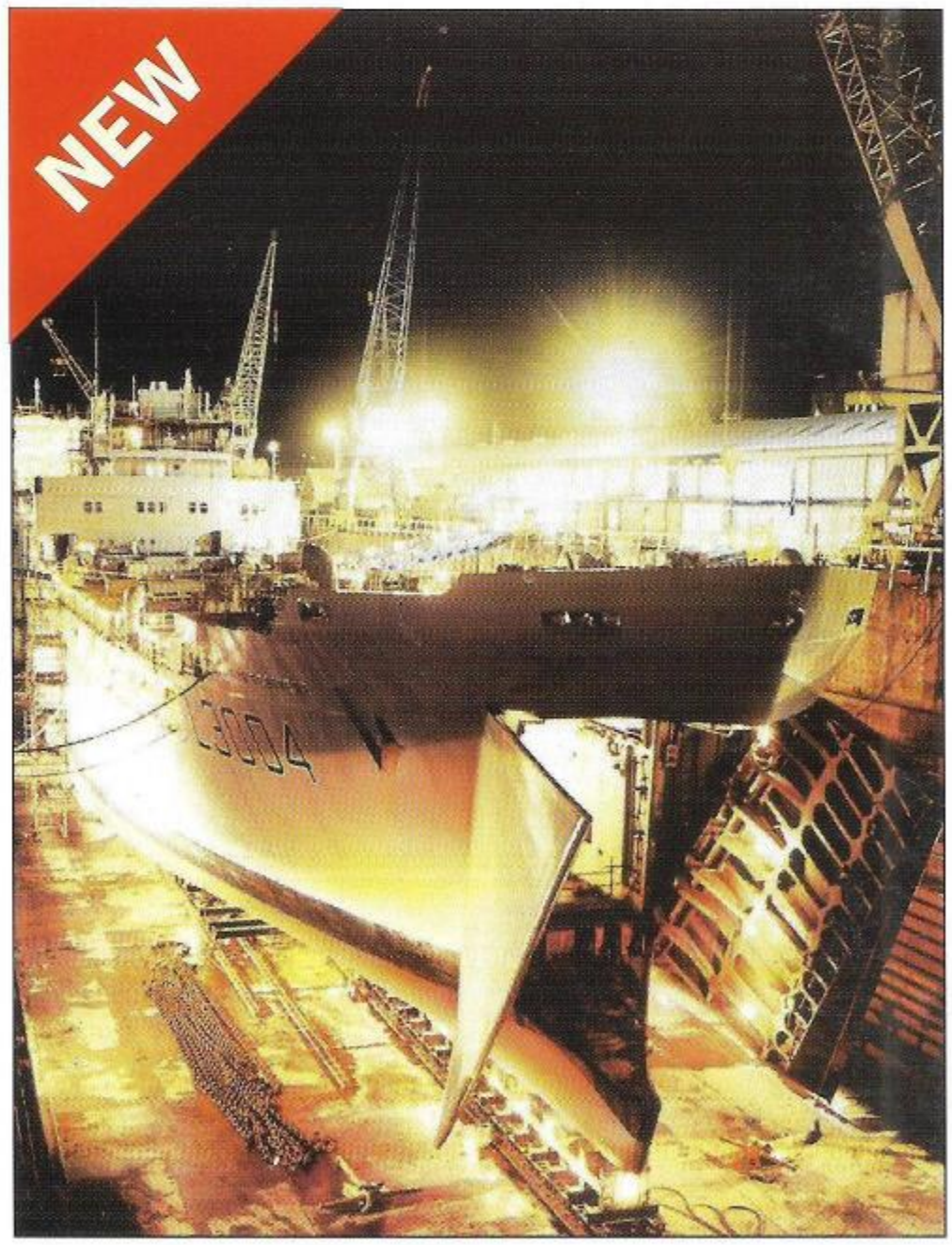

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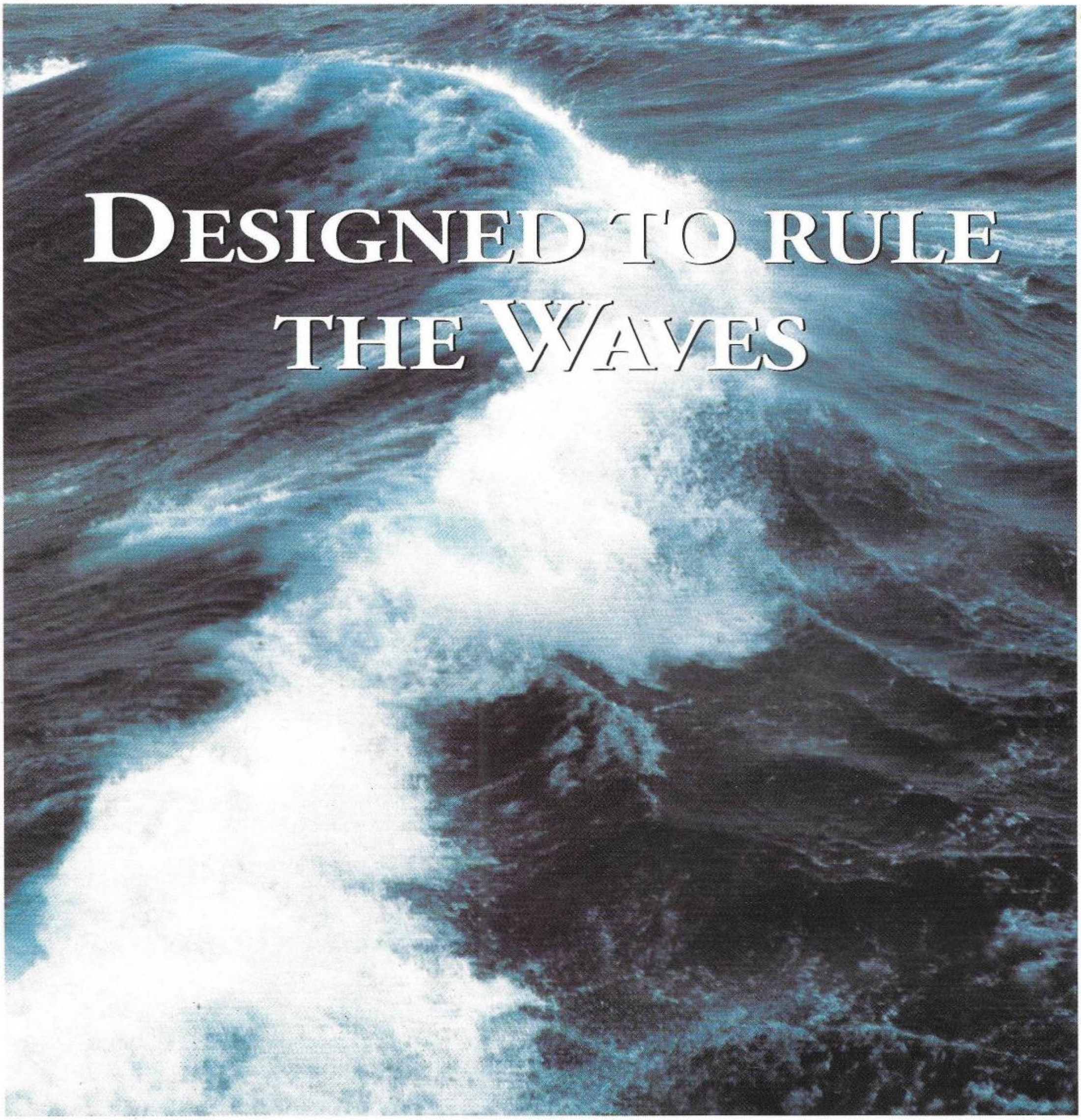

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Introduction

The aim of *Jane's Major Warships* is to present the reader with all the information currently available on all major naval combatants. The book includes all but the very smallest combat craft and excludes patrol craft, auxiliaries, logistic vessels, harbour craft, training ships, coastguard vessels, army vessels and small boats, although some of these may follow in later volumes. In general terms, the cut-off point between major ships which have been included and minor ships to be excluded has been taken as 500 tonnes full load displacement, although a degree of flexibility has had to be applied, particularly in fast attack craft.

Jane's Major Warships is divided into two volumes covering:

Volume I
- Introduction
- Aircraft carriers
- Shipboard aircraft
- Ballistic missile submarines
- Nuclear-powered attack submarines
- Diesel-electric-powered attack submarines
- Cruisers
- Destroyers
- Index (to Volume I only)

Volume II
- Frigates
- Corvettes
- Fast attack craft
- Amphibious warfare ships
- Mine countermeasures vessels
- Index (to Volume II only)

Each entry is designed to give the reader all the information required on the ship concerned, without having to cross-refer to other parts of the book. The only exception is aircraft, where a certain amount of information is included in the ship entry, with full details given in the 'Shipboard Aircraft' section.

This means that short descriptions and specifications of weapons and electronic equipment are repeated in different entries, an approach which has been adopted in order that the reader only needs to make a 'one-stop' consultation of the book and find everything that is required. However, it should be noted that each weapon or electronic entry is tailored to give information specific to the ship concerned.

If even more detailed information or background on a weapons system or electronic equipment is needed then the reader should refer to the relevant *Jane's* yearbook, such as *Jane's Naval Weapons Systems, Jane's Underwater Warfare Systems* or *Jane's Radar and Electronic Warfare Systems.*

A certain amount of historical information is given in some class entries. This is considered essential to place the class in its contemporary context, and to show how the surviving ships have developed from their original to their current states.

TABLE I. NAVAL RANKS BASED ON SIZE OF SHIP

US/UK rank[1]	France[2]	Germany	Italy	Spain[3]
Captain	*Capitaine de Vaisseau*	*Kapitän zur See*	*Capitano di Vascello*	*Capitan de Navio*
Commander	*Capitaine de Frégate*	*Fregatten-Kapitän*	*Capitano di Fregata*	*Capitan de Fregata*
Lieutenant-Commander	*Capitaine de Corvette*	*Korvetten-Kapitän*	*Capitano di Corvetta*	*Capitan de Corbeta*

Notes:
(1) Also followed by most Commonwealth navies (except for Singapore), and a number of other navies, including Japan and South Korea.
(2) Also followed by most former French colonial territories.
(3) Followed by many South American navies.

Warship Designations

One of the difficulties in categorising warships is that there is no international agreement on the definitions of the various types of ship. Thus, in Western navies the description of warships follows a pattern that is fundamentally traditional, classifying warships into groups such as cruisers, destroyers, frigates and corvettes. These descriptions give a very general idea of the size, role and capability of the ship, so that, in the most general terms, a frigate is larger and more capable than a corvette, while a destroyer is larger and more capable still. The only known source of such warship designations is Standardised NATO Agreement Number 11 of 1966 (STANAG 11/66) which, of course, has no authority outside the Alliance, but as there is no known comparable document, it forms a useful basis for designations.

STANAG 11/66 is summarised at Appendix 1 to this Introduction and it will be seen that it attempts to classify every type of naval vessel or craft to be found in any navy. Experience suggests that it tends to be amended to suit national changes rather than to set standards with which nations will comply. It is, nevertheless, the only standardisation document in this area.

It should be noted also that warships are sometimes categorised for motives other than the purely naval. There have been occasions, for example, where navies have deemed it necessary to mislead potential enemies (or friendly politicians) into thinking that a proposed warship is smaller and less significant than it really is. Thus, in the past, cruiser-sized ships have been described as destroyers, and frigates as corvettes. Conversely, navies have sometimes wished a potentially hostile power to over- rather than underestimate their capabilities and so they have placed a warship in a category greater than is properly the case, for example, by describing a ship which most navies would classify as a corvette, a 'frigate'.

An additional factor is that many navies enshrine the relative size of ships in the middle-grade officers' ranks titles, as shown in Table 1, where a four-ring captain is a 'captain of ship' (in the sense of a traditional sailing 'ship-of-the-line') while a commander is a 'captain of frigate' and a lieutenant-commander is a 'captain of corvette.'

A further complication arises where ships are rebuilt to fit a different role from that for which they were originally designed. Sometimes the ships are redesignated to match this change; when the British Royal Navy rebuilt a large number of Second World War destroyers in the 1950s as convoy anti-submarine escorts, for example, it changed their designation to 'frigate.' Other navies, however, do not do this, and ex-US Navy 'Gearing' and 'Sumner' class ships have remained designated 'destroyers' throughout their lives, regardless of their changes in roles.

A cruiser is defined by STANAG 11/66 as a vessel of '150 m (492 ft) and over', with subdivisions of CA (a cruiser with 150 mm (6 in) guns or larger and carrying no missiles) or CG (cruiser having guided missiles as a main armament). Despite this, the US Navy's 'Kidd' class ships are designated destroyers, even though they are 171 m (561 ft) in length, displace 9,574 tonnes and have an armament as heavy as that of cruisers, such as the 'California' and 'Bainbridge' classes. Similarly, the 'Ticonderoga' and 'Spruance' classes share a common hull and propulsion system, but the former are designated cruisers and the latter destroyers.

According to STANAG 11/66, destroyers have a length bracket of 95 to 140 m (312 to 459 ft), whereas the frigate length bracket is somewhat greater at 75 to 150 m (246 to 492 ft). The difference between the two lies in the role, where destroyers are optimised for '. . . operations with strike, ASW, and amphibious forces, and to perform screening and convoy duties' while frigates are '. . . fitted primarily to fulfil an ASW role: generally has lighter surface armament than DD.' The surface armament stipulation seems to have been overtaken by modern technology, where most destroyers and all but the smallest frigates are armed with one 76 mm gun and eight Harpoon SSM launchers.

The Russian system is shown in Table II. This system is also a mixture of functional designations (large anti-submarine ship,

TABLE II. RUSSIAN WARSHIP DESIGNATIONS[1]

Russian designation	Russian abbreviation	English translation	Examples	Western designation
Raketnyy Kreyser	RKR	Missile cruiser	Kirov Slava	Battle cruiser Missile cruiser[2]
Kreyser	KR	Cruiser	Sverdlov	Cruiser
Bol'shoy Protivolodochnyy Korabl'	BPK	Large anti-submarine ship	Kara Udaloy	Cruiser Destroyer
Eskadrennyy Minonosets	EM	Destroyer	Sovremenny	Destroyer
Storozhevoy Korabl'	SKR	Patrol ship	Krivak Koni	Frigate
Malyy Raketnyy	MRK	Small missile ship	Tarantul Nanuchka	Corvette
Raketnyy Kater	RKA	Missile cutter	Osa	Fast attack craft[3]

Notes:
(1) This is only a small selection, and concerns the major warship types only.
(2) The 'Kirov' class is much larger than the 'Slava' class but in the Russian Navy both share the designation RKR. In the West, however, the Kirov is generally designated a battle cruiser (BC), a designation previously used in the first half of the twentieth century to denote a ship of battleship size and with a battleship's armament, but which sacrificed armour for speed. (BC does not appear in STANAG 11/66)
(3) Fast attack craft (FAC) is not a NATO designation, but is widely accepted.

patrol ship) and of traditional designations such as *kreyser* (cruiser) and *eskadrennyy minonosets* (destroyer).

Entries

Some further explanations of the layout and contents of the entries is in Appendix 2.

Parts of a ship

For the convenience of non-specialist readers, diagrams are given in Appendix 3 which illustrate the naval terminology used in this book.

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A book such as this could not be prepared by the editor alone and I wish to record my heartfelt thanks to the following:

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Contributions

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APPENDIX 1

The NATO Standard Ship Designator System (Extract)

Serial	Letter designator	STANAG 11/66[1] Reporting title	Description[1]	Editors' comments
1.	BB	Battleship, general	General designator for battleship. Largest possible type of surface combatant designed for surface action. Showing a reasonable compromise between speed, protection and armament.	1. Last applied to US 'Iowa' class. 2. Note there is NO category of 'battle-cruiser'
3.	CA	Cruiser, gun	A cruiser with guns (15 cm (6 in)) or larger as its main armament and which has no missiles	
4.	CC	Cruiser, general	General designator for all cruiser-type ships of 140 m (459 ft) or more	
5.	CG	Cruiser, guided missile	A ship of cruiser size, having a guided missile system as main armament	Peruvian *Almirante Grau* is one of few remaining examples
6.	CH	Cruiser, helicopter	A cruiser equipped with a major flight deck with a primary mission of operating and maintaining helicopters.	Peruvian *Aguirre* is one of few remaining examples
7.	CV	Aircraft carrier	1. General designator for aircraft carriers 2. Designator for multirole aircraft carriers	
8.	CVH	Aircraft carrier, VSTOL/ helicopter	A carrier not fitted with arrest gear/catapult, operating VSTOL and/or helicopters, which is not an amphibious or mine warfare vessel.	
9.	CVS	Aircraft carrier, ASW	Carrier capable of operating VSTOL and/or helicopters in sustained ASW operations and escort duties	For example, British 'Invincible' class as originally built
10.	DD	Destroyer, general	General designator for destroyer type-ships. Major surface combatant in range of about 95-140 m (312-459 ft). General mission is to conduct operations with strike, ASW, amphibious forces and to perform screening and convoy duties. May have helicopters not especially fitted for ASW.	Suffix 'G' is frequently added to indicate primary missile armament.
11.	DE	Destroyer, escort	A destroyer-sized ship optimised for escort duties	Has not been applied to a new . class for many years
12.	FF	Frigate/corvette, general	General description for a frigate. A surface combatant in size range of about 75-150 m (246-492 ft). Fitted primarily to fulfil an ASW role: generally has lighter surface armament than DD	Suffix 'G' is frequently added to indicate primary missile armament
13.	FS	Corvette	Small escort in size range 60-100 m (197-328 ft)	For example, Italian 'Minerva' class
14.	LCAC	Landing craft, air-cushion	A high-speed (40 kts) assault landing craft capable of travelling over land or water from over-the-horizon distances (12-200 n miles) using air-cushion/gas-turbine propulsion	
15.	LCC	Amphibious command ship	Command ship for amphibious task force and landing operations. May carry a limited number of troops and supplies for the headquarters element of the landing force	For example, US Navy 'Blue Ridge' class
16.	LCM	Landing craft, mechanised	Landing craft in the range 15-25 m (49-82 ft), capable of carrying one tank or 50-200 troops. Must have landing ramp	
17.	LCP	Landing craft personnel	Landing craft suitable only for personnel. Size range 7.5 to 30 m (24.6-98 ft) overall. May be fast and/or ramped.	
18.	LCU	Landing craft, utility	All-purpose landing craft. Size range 25-55 m (82-180 ft). Capable of handling 2-3 tanks or 300-450 troops. Must have landing ramp or other landing facilities. Full load displacement of 120-500 tonnes.	
19.	LCVP	Landing craft, vehicle, personnel	Similar in size to LCP but capable of carrying light vehicle in place of troops. Must have bow ramp	
20.	LCW	Landing craft, swimmer support	High-speed craft utilised primarily for underwater demolition and/or special warfare operations	
21.	LFS	Amphibious fire support ship	Landing ship converted for use as amphibious assaults (sic). Armament is usually rocket launchers, but may also have bombardment guns; may or may not carry amphibious troops	

Serial	Letter designator	STANAG 11/66[1] Reporting title	Description[1]	Editors' comments
22.	LHA	Amphibious general assault ship	A large general purpose amphibious assault ship which embarks and lands elements of an assault force in both organic helicopters and organic landing craft. Capable of carrying about 1,800 assault troops. Must have internal stowage and ramp and flooded well capability for vehicles or craft.	
23.	LHD	Amphibious assault ship, multipurpose	A large multipurpose amphibious ship that embarks and lands elements of a landing force in assaults by helicopter, landing craft and amphibious vehicles. Also can conduct sea control and power projection missions with VSTOL aircraft and ASW helicopters	
24.	LKA	Amphibious cargo ship	Ship which carries supplies for amphibious assaults and can land same in its own organic landing craft	
25.	LL	Amphibious vessel, general	General designator for amphibious vessels	Is never used
26.	LPA	Amphibious transport, personnel	Ship capable of carrying 1,300-1,500 troops and landing them in its own landing craft	
27.	LPD	Amphibious transport, dock	A ship which carries about 1,000 troops. Capable of carrying up to nine LCM; primarily a troop ship and armoured car carrier, with considerable internal be rthing space. Must have permanent helicopter platform	
28.	LPH	Amphibious assault ship	A large helicopter carrier with the mission of transporting and landing about 1,800 assault troops with its own aircraft. Employment of organic landing craft not a principal function	
29.	LSD	Landing ship, dock	Primarily a tank and vehicle carrier, but capable of transporting 150-400 assault troops and launching them embarked in organic landing craft without off-loading in the landing area. Need not have a helicopter platform.	
30.	LSL	Landing ship, logistics	A landing ship capable of carrying initial, second echelon and follow-on equipment, vehicles and troops. Normally ramped. Not part of initial assault force.	
31.	LSM	Landing ship, medium	Ship in size range 45-85 m (148-279 ft). Capable of beaching to land troops and/or tanks. Must have bow doors and/or landing ramp	
32.	LST	Landing ship, tank	Ship in size range 85-160 m (279-525 ft) to transport troops, vehicles and tanks for amphibious assault. Must have bow doors and/or landing ramp	See Note 2.
33.	LSV	Landing ship, vehicle	Ship in size range 45-60 m (148-197 ft) overall intended primarily to carry vehicles. Must have bow doors and/or landing ramp. Not capable of beaching.	
34.	MM	Mine warfare vessels, general	General designator for mine warfare vessels	
35.	MCCS	MCM command and support ship	An armed combatant fitted for the command and support of MCM vessels and their equipment	
36.	MCD	MCM vessel, diving	A mine countermeasures vessel specially equipped to carry out and support diving operations	
37.	MCJ	MCM vessel, hovercraft	Specially equipped for MCM operations	
38.	MCMV	Mine countermeasures vessel, general	General designator for mine countermeasures vessels	
39.	MCS	MCM support ship	An armed combatant fitted for the control and support of MCM vessels in combat situations. Has limited facilities for repair of MCM vessels and their equipment	
40.	MH	Minehunter, general	Ship fitted with specific equipment to hunt mines	
41.	MHA	Minehunter, auxiliary	Any seagoing ship not designed as a minehunter but converted to such use	
42.	MHC	Minehunter, coastal	Very low-magnetic signature ship in size range 25-60 m (82-197 ft) with an enhanced minehunting capability. Must be equipped with unusually sensitive gear for the detection of sea mines. May or may not carry sweep gear as well. May carry frogmen for mine clearance.	
43.	MHSC	Minehunter/sweeper, coastal	A mine warfare craft capable of hunting and sweeping mines in coastal waters	
44.	MHSO	Minehunter/sweeper, ocean	A mine warfare craft capable of hunting and sweeping mines in the open ocean	

Serial	Letter designator	STANAG 11/66[1] Reporting title	Description[1]	Editors' comments
45.	MHI	Minehunter inshore	Same basic function as MHC but designed to operate in more shallow waters and estuaries	
46.	MHO	Minehunter ocean	Same basic function as MHC but operates primarily in open seas	
47.	ML	Minelayer, general	Any ship with a primary mission of laying mines	
48.	MLA	Minelayer auxiliary	Any fishing or merchant ship having both capability and mission to lay mines	
49.	MLC	Minelayer coastal	Minelayer in the size range 50-85 m (164-279 ft) overall	
50.	MLI	Minelayer inshore	Minelayer in the size range 25-50 m (82-164 ft)	
51.	MLO	Minelayer ocean	Large ship over 85 m (279 ft) used primarily for minelaying	
52.	MLR	Minelayer river	Small minelayer 15 m (49 ft) or less, suitable only for operations in rivers or protected roadsteads	
53.	MLS	Minelayer, support ship	A large armed ship (over 90 m) capable of extensive minelaying, but not capable of speeds up to 30 kts. Has facilities for command and control of mine warfare ships and boats in combat environment. Has limited support capability.	
54.	MS	Minesweeper, general	Ship designed to sweep mines	
55.	MSA	Minesweeper, auxiliary	Any seagoing ship not designed as a minesweeper but converted to such use.	
56.	MSC	Minesweeper, coastal	Non-magnetic minesweeper between 40-60 m (131-197 ft)	
57.	MSCD	Minesweeper coastal with drone(s)	Coastal minesweeper capable of deploying and/or controlling unmanned remote-controlled or towed vehicle(s) capable of clearing mines	
58.	MSF	Minesweeper, fleet	Minesweeper in size range 46 m (151 ft) or more which cannot be regarded as non-magnetic	
59.	MSI	Minesweeper, inshore	Minesweeper between 20-40 m (65.6-131 ft). Intended and equipped for inshore minesweeping	
60.	MSO	Minesweeper, ocean	Non-magnetic minesweeper 45 m (148 ft) or more	
61.	MSR	Minesweeper, river	Shallow water minesweeper in the size range 12.5-25 m (41-82 ft), which has been armoured to provide protection for crew in close combat situations. Within the USN a converted LCM-6 known as MSM	
62.	PP	Patrol vessel, general	General designator for patrol vessels	
63.	PB	Patrol boat, general	Coastal patrol unit intended for a basically coastguard function. Should include any coastal patrol ship under 45 m (148 ft) which cannot qualify as a PG in armament. May be unarmed	
64.	PBF	Patrol boat, fast	Unit qualifying as a PB but capable of at least 35 kts	
65.	PBR	Patrol boat, river/ roadstead	Light armed unit generally suitable by design only for operations in sheltered waters, such as rivers and roadsteads	
66.	PBS	Patrol boat, fire support	High-speed (35 kts) craft not over 30 m (98 ft) in length, fitted and employed primarily to provide close in fire support. The primary weapons are multiple rocket launchers, but can have guns, as well	
67.	PC	Patrol subchaser, general	Ship in size range 35-55 m (115-180.5 ft) designed and fitted primarily for ASW role	
68.	PCE	Patrol boat, escort	Ship in size range 55-75 m (180.5-246 ft) designed and fitted primarily for ASW role and coastal duty. Improved seakeeping, vice mere large size. Distinguishes PCE from PC and ships lacking this should be typed PC.	
69.	PCF	Patrol subchaser, fast	Same basic function as PC, but capable of speeds of at least 35 kts	
70.	PG	Patrol ship, general	Patrol, blockade and surveillance ship in range 45-85 m (148-279 ft) overall. Designed to operate in other than open ocean areas. Has special mission of attacking hostile ships. Must have at least 76 mm main armament.	
71.	PGF	Patrol ship, fast	Same as PG, but with speed of at least 35 kts	
72.	PGS	Patrol ship, ASW	ASW patrol ship in range 45-85 m (148-279 ft). Fitted with medium-range sonar and ASW weapons	

Serial	Letter designator	STANAG 11/66[1] Reporting title	Description[1]	Editors' comments
73.	PHM	Patrol combatant, guided missile	A high-speed patrol combatant (hydrofoil) with SSM capability, which can operate offensively against surface combatants and conduct surveillance screening and special operations.	
74.	PT	Patrol/torpedo boat	High-speed (35 kts) anti-surface ship torpedo-equipped unit 20-30 m (65.6-98 ft)	
75.	SS	Submarine, general	General designator for submarines	
76.	SSA	Submarine, auxiliary	Submarine used mainly in a non-combatant role which has at least a residual combat capability	
77.	SSB	Submarine, ballistic missile	Submarine armed with ballistic missiles normally deployed on strategic missions	
78.	SSBN	Submarine, ballistic missile, nuclear	Primary strategic nuclear submarine armed with ballistic missiles	
79.	SSC	Submarine, coastal	Submarine designed primarily for operations in coastal and shallow water	
80.	SSG	Submarine, attack, surface missile	A submarine fitted with underwater or surface-to-surface missiles	
81.	SSGN	Submarine, attack, surface missile, nuclear	A nuclear submarine fitted with underwater or surface-to-surface missiles	
82.	SSK	Submarine, patrol	A non-nuclear, long-range patrol submarine. May have primary anti-surface or anti-submarine role	
83.	SSN	Submarine, attack, nuclear	A nuclear-propelled attack submarine that has both anti-submarine and anti-surface capability	

Notes:
(1) These are taken verbatim from the STANAG 11/1966 Edition 4 (Amendment 6).
(2) It should be noted that although the designation 'LST' still exists, the designation 'LCT' (landing-craft, tank) is not in the STANAG.

Suffixes
The following suffixes can be added to qualify most of the preceding groups:

A A unit equipped with force surface-to-surface (SSM) or underwater-to-surface (USM) guided missiles. (Notes 1,3,4)
B [The suffix 'B' is NOT used]
C A ship equipped with a critical angle towed array system (CATAS)
D A ship equipped with a depressed towed array system (DTAS)
E A unit for experimental purposes
F A ship other than a CV type equipped with fixed-wing aircraft
G A unit equipped with force surface-to-air guided missiles (SAM). (Notes 1,3,4)
H A ship equipped with helicopter(s)
I [The suffix 'I' is NOT used]
J A unit that is either an air-cushion or surface-effect design
K A ship equipped with hydrofoils
L A unit minelaying capability (Note 5)
M A ship equipped with more than one force missile system; that is, SAM + SAM, SAM + SUM. (Notes 1,3,4)
N A ship or submarine using nuclear propulsion (Note 2)
O, P } [Suffixes 'O' and 'P' are NOT used]
Q A unit configured for, or employed on, a Command, Control and Communications mission
R A unit equipped primarily to carry out radar picket duties
S A unit with minesweeping/minehunting capability (Note 5)
T A unit used primarily for training with a reduced operational capability
U A unit equipped with surface-to-underwater (SUM) or underwater-to-underwater (UUM) missile-delivered force weapon. (Notes 1,3,4)
V A ship equipped with variable depth sonar (VDS)
W A ship without organic helicopter(s) but equipped with a flight deck and limited helicopter facilities
X, Y } [Suffixes 'X' and 'Y' are NOT used]
Z A non-self-propelled ship or craft

Notes:
(1) Suffixes may be combined as required but suffix 'M' should not be used with suffixes 'A,' 'G,' or 'U'.
(2) Suffix 'N', when used, is normally the last character.
(3) A force weapon contributes to the overall force offensive and/or defensive posture.
(4) The suffix 'G' for US Navy ships indicates a ship equipped with surface-to-air guided missiles (SAM) and does not exclude other systems (SSM and/or SUM). The US Navy does not use suffixes 'A', 'M' or 'U' to indicate missile systems.
(5) To be used for vessels whose primary purpose is not mine warfare.

APPENDIX 2

Entries

Classes

(a) Ships are grouped together by classes under the country where the design originated, and within such classes by alphabetical order of countries.
(b) Where necessary, an introduction or 'overview' is given, which is designed to give the reader the overall picture, to show how the class originated and how it was dispersed, either by building to foreign orders, or by foreign sales at the end of the ships' careers in the original navies.

Building programme. The current status of the class is divided into:
(a) 'Built' The total number constructed
(b) 'Building' The total number on firm order and under construction
(c) 'Active' The total in service on 1 January 1997
(d) 'Projected' The total on firm order
(e) Where there is a degree of uncertainty a question mark is appended.

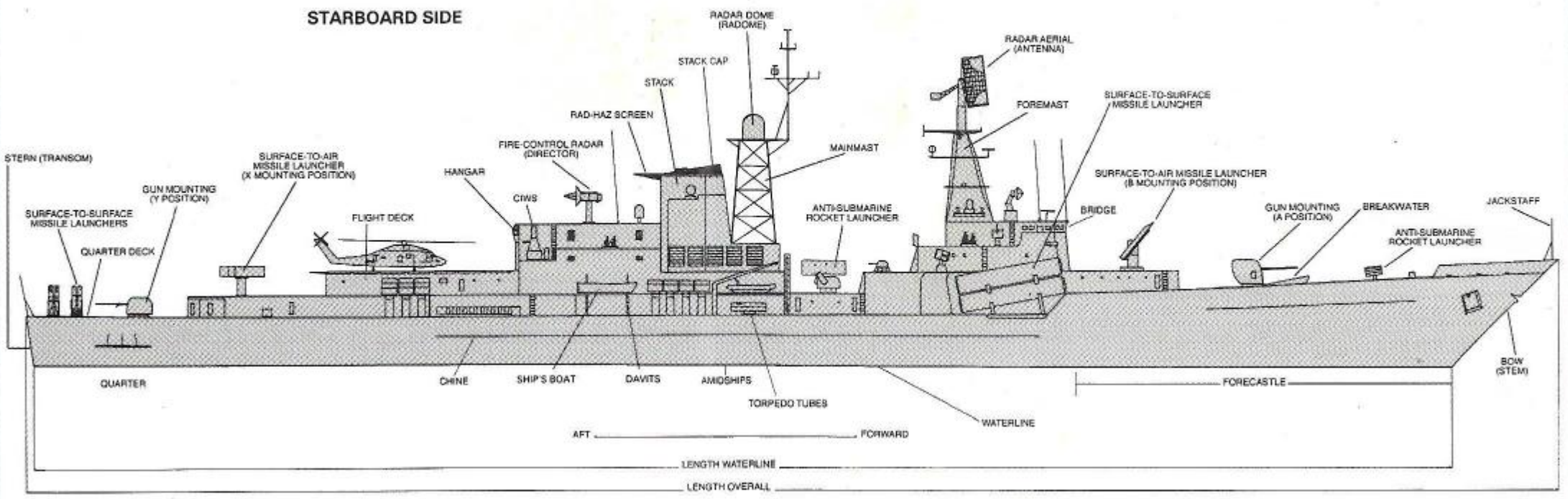
Displacement. This is given as
(a) Light: without fuel, water or ammunition
(b) Standard: as defined by Washington Naval Conference 1922 — fully manned and stored but without fuel or reserve feed-water
(c) Full load: fully laden with all stores, ammunition, fuel and water

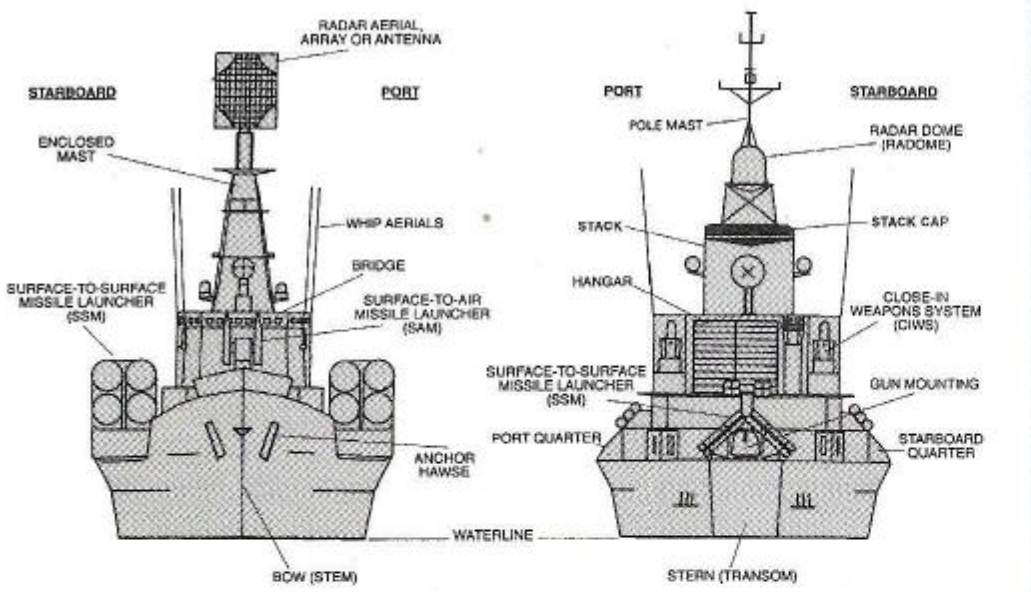
Dimensions

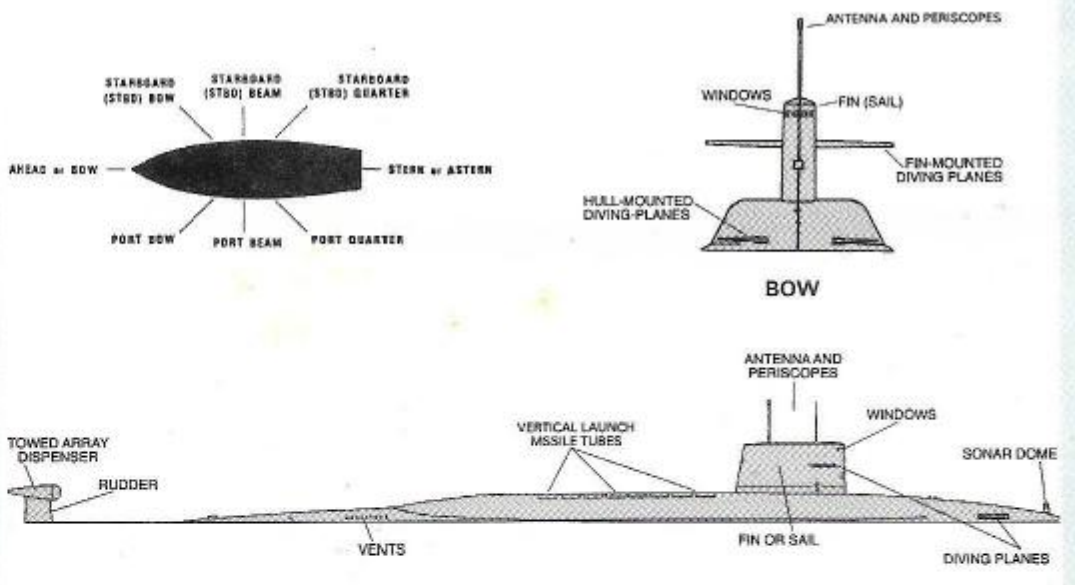
(a) Length. This is length overall, unless specified by:
  i: '(oa)' length overall between extremities
  ii: '(wl)' length of waterline at standard load
(b) Beam. Maximum width of the hull, but excluding sponsons.
(c) Draught. Draught at standard load at deepest point

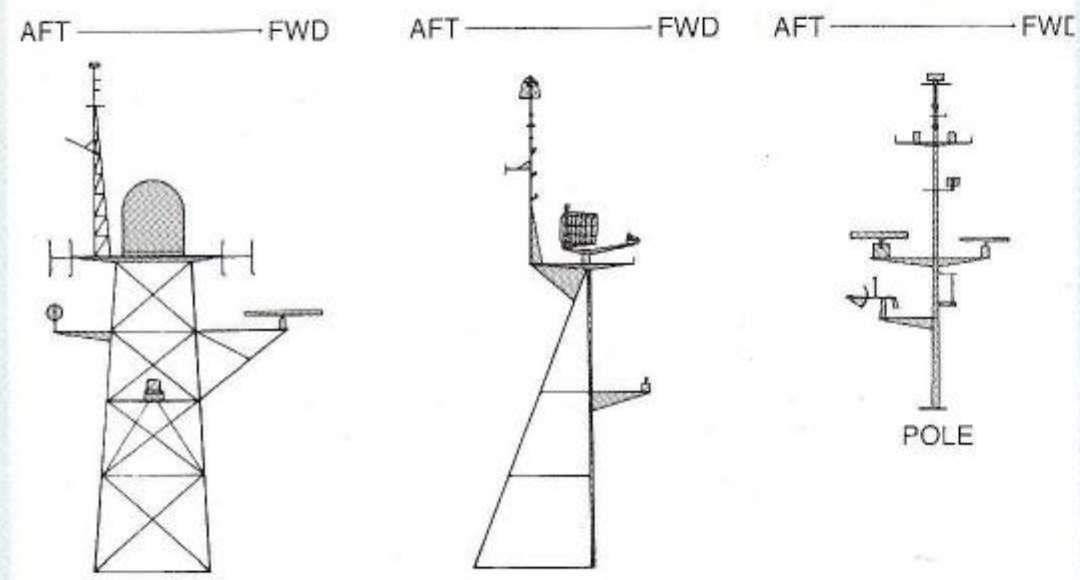
'Principe de Asturias' *class aircraft carrier* (H M Steele)

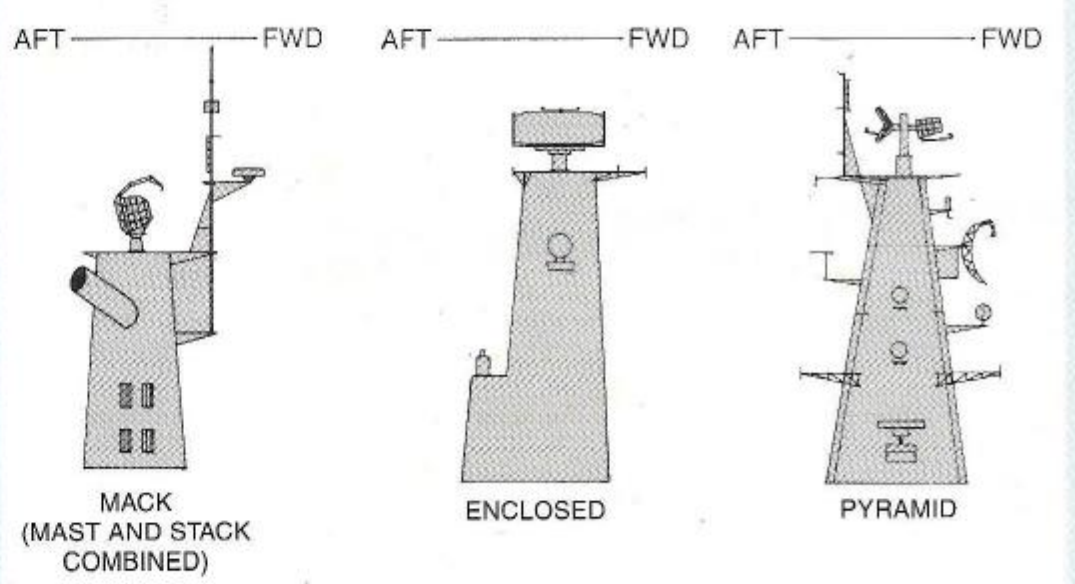
APPENDIX 3











Above are composite diagrams of warships, submarines and masts, which are annotated for the benefit of non-specialist readers

Glossary

AAW Anti-air warfare
ACDS Advanced combat direction system
ACV Air cushion vehicle
AEW Airborne early warning
AIP Air independent propulsion
ANV Advanced naval vehicle
ARM Anti-radiation missile
A/S, ASW Anti-submarine (warfare)
ASuW Anti-Surface Warfare
ASM Air-to-surface missile
AUV Autonomous undersea vehicle
BPDMS Base point defence missile system
Cal Calibre — the internal diameter of a gun barrel; also used for measuring length of the barrel, for example, a 152 mm gun 50 calibres long (152 mm/50) would be 7.6 m (25 ft) long
cep Circular Error Probable — a measure of the accuracy of missiles, bombs and artillery shells, being the diameter of a circle within which 50 per cent of the missiles/projectiles would land
CIWS Close in weapon system
COD Carrier onboard delivery
CODAG, CODOG Descriptions of mixed propulsion systems: CODLAG = combined diesel-electric and gas turbine
COGAG = combined gas turbine and gas turbine
COGOG = combined gas turbine or gas turbine
COSAG = combined steam and gas turbine
CONAS = combined nuclear and steam
cp Controllable pitch (propellers)
DC Depth charge
DCT Depth charge thrower
DP Dual-purpose; a gun which can be used against both surface and aircraft targets
Displacement Basically the weight of water displaced by a ship's hull when floating: (a) Light: without fuel, water or ammunition
(b) Standard: as defined by Washington Naval Conference 1922 — fully manned and stored but without fuel or reserve feed-water
(c) Full load: fully laden with all stores, ammunition, fuel and water
DSRV Deep submergence recovery vessel
dwt Deadweight tonnage
ECM Electronic countermeasures, for example, jamming
ECCM Electronic counter-countermeasures
EEZ Exclusive economic zone
EHF Extreme high frequency (30-300 GHz)
ELF Extreme low frequency (0-3 kHz)
ELINT Electronic intelligence, for example, recording radar, radio, and so on
ESM Electronic support measures, for example, intercept
EW Electronic warfare
FAC Fast attack craft
FLIR Forward looking infra-red radar
FRAM Fleet rehabilitation and modernisation programme (a US Navy programme in the 1960s)
GFCS Gun fire control system
GMLS Guided missile launch system (US)
GPS Geographical positioning system
grt Gross registered tonnage
GWS Guided weapon system
HF High frequency (3-30 MHz)
HMG Heavy machine gun
Horsepower (hp) Power developed or applied: or (hp(m))
(a) bhp: brake horsepower = power available at the crankshaft
(b) shp: shaft horsepower = power delivered to the propeller shaft
(c) ihp: indicated horsepower = power produced by expansion of gases in the cylinders of reciprocating steam engines
(d) 1 kW = 1.341 hp = 1.360 metric hp. 1 hp = 0.746 kW = 1.014 metric hp. 1 metric hp = 0.735 kW = 0.968 hp
(e) Sustained horsepower may be different for similar engines in different conditions
IFF Identification friend/foe
kT Kiloton; measure of the power of a nuclear explosion, where 1 kT is equivalent to the effect of 1,000 tons of TNT
kW Kilowatt
LAMPS Light airborne multipurpose system (US)
Length The length of a ship, which can be expressed in various ways:
(a) oa: overall = length between extremities
(b) pp: between perpendiculars = between fore side of the stem and after side of the rudderpost
(c) wl: waterline = between extremities on the waterline
LF Low frequency (30-300 kHz)
LMCR Liquid metal cooled reactor
LRMP Long-range maritime patrol
MAD Magnetic Anomaly Detector — a system used by aircraft to detect submarines by identifying the movement of a steel body through the earth's magnetic field
MAP US Military Assistance Programme
MCMV Mine Countermeasures Vessel
MDF Maritime defence force
Measurement *see* Tonnage
MF Medium frequency (300 kHz-3 MHz)
MFCS Missile fire-control system
MG Machine gun
MIRV Multiple, independently targetable re-entry vehicle
MRV Multiple re-entry vehicle
MSA Maritime Safety Agency (Japanese)
MSC Military Sealift Command (US)
MW Megawatt
NBC Nuclear, biological and chemical (warfare)
net Net registered tonnage
n miles Nautical miles
NTDS Naval tactical direction system (US)
NTU New Threat Upgrade (US)
oa Overall length; that is, the length between the two extremities of the hull
OTC Officer in Tactical Command
PDMS Point defence missile system (US)
PUFFS Passive underwater fire-control system (US)
PWR Pressurised water reactor
RAM Radar absorbent material
RAS Replenishment at sea
RBU Anti-submarine rocket launcher (Russian)
RIB Rigid inflatable boat
Ro-ro Roll-on/roll-off
ROV Remote operated vehicle
rpm Revolutions per minute of engines, propellers, radar aerials and so on
SAM Surface-to-air missile
SAR Search and rescue
Satcom Satellite communications
SDV Swimmer delivery vehicle
SES Surface effect ship
SHF Super high frequency (3-30 GHz)
SINS Ship's inertial navigation system
SLBM Submarine-launched ballistic missile
SLCM Ship-launched cruise missile
SLEP Service Life Extension Program
SRBOC Super rapid blooming offboard countermeasure
SSBN Submarine, ballistic missile, nuclear-powered (that is, nuclear-powered, strategic missile submarine)
SSDE/SSE Submerged signal and decoy ejector
SSK diesel electric-powered submarine
SSM Surface-to-surface missile
SSN attack submarine, nuclear powered
STIR Surveillance Target Indicator Radar
SUBROC/ASROC Rocket-assisted torpedo, part of whose range is in the air (US)
SURTASS Surface Towed Array Surveillance System (US)
SUWN-1 Surface-to-underwater missile launcher (Russian)
SWATH Small waterplane area twin hull
TACAN TACtical Air Navigation beacon
TACTASS TACtical Towed Acoustic Sensor System (US)
TAS Target Acquisition System
TASS Towed Array Surveillance System
Tonnage Measurement tonnes, computed on capacity of a ship's hull rather than its 'displacement' (see above):
(a) Gross: the internal volume of all spaces within the hull and all permanently enclosed spaces above decks that are available for cargo, stores and accommodation. The result in cubic feet divided by 100 = gross tonnage
(b) Net: gross minus all those spaces used for machinery, accommodation and so on ('non-earning' spaces)
(c) Deadweight (dwt): the amount of cargo, bunkers, stores and so on that a ship can carry at her load draught
Tonnes Metric ton = 1,000 kg = 0.98 tons
UHF Ultra-high frequency (300 MHz-3 GHz)
UUV Unmanned undersea vehicle
VDS Variable depth sonar which is lowered to best listening depth. Known as 'dunking' sonar in helicopters
Vertrep Vertical replenishment; that is, resupply at sea using helicopters
VHF Very High frequency (30-300 kHz)
VLF Very low frequency (3-30 kHz)
VLS Vertical launch system
VSTOL Vertical or short take-off/landing
VTOL Vertical take off/landing
WIG Wing-in-ground effect
wl Waterline length

COUNTRY NAMES

Throughout this work, where it is necessary to list countries, this is done using the UN and NATO convention of alphabetical order according to the initial letter of the country name, using the anglicised spelling. The order in such a listing does not, therefore, imply any suggestion of relative size or importance, or of comparative merit.

In the case of Russia and the Soviet Union the following convention has been applied:

In any references of a purely geographical nature the name 'Russia' is used and, as far as possible, names of regions and towns are given in their modern (1997) form. Thus, for example, the name 'St Petersburg' is used even when the event referred to may have taken place in the Soviet era.

In references to the country and the navy, the terms Soviet Union and Soviet Navy are used where the events referred to happened before 1990. For events after that date the terms Russia and Russian Navy are used.

ELECTROMAGNETIC SPECTRUM

Some confusion has been caused over the past few years by the use of two different systems to describe radio frequencies and wavelengths. One particular problem has been the use of frequency band letters by the EW fraternity and the waveband letters by the radar fraternity. To avoid this, *Jane's Major Warships* follows the lead given by *Jane's Radar and Electronic Warfare Systems* in using the NATO frequency band designation as standard throughout (ie, Column (1) below). In order that readers can evaluate wavelength against frequency the wavelength letters are given in Column (3).

RADAR BANDS

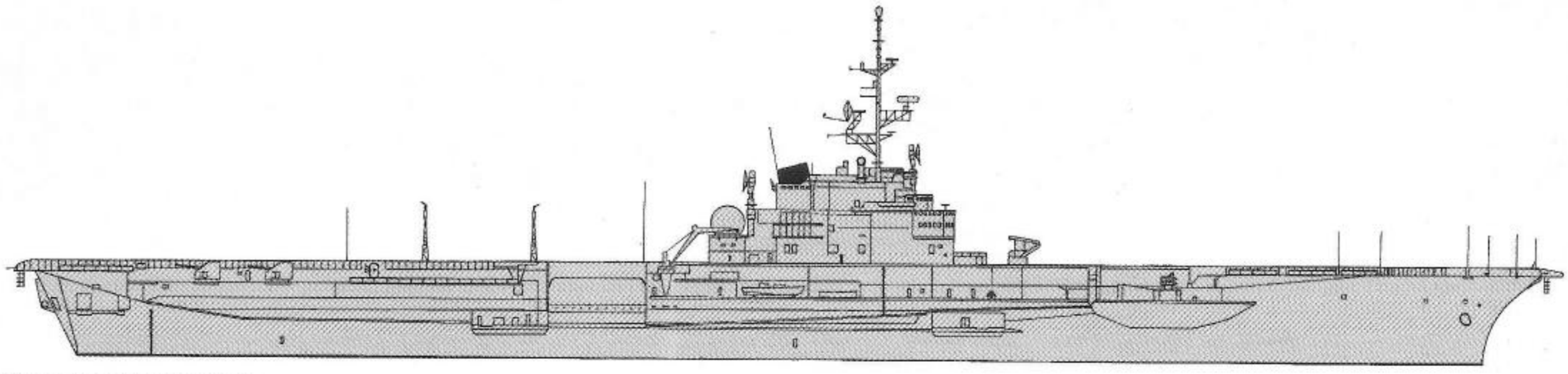
Frequency band	Frequency	Wavelength band	Wavelength
(1)	(2)	(3)	(4)
A	100-300 MHz	VHF	300-100 cm
B	300-500 MHz	UHF	100-60 cm
C	0.5-1 GHz	UHF	60-30 cm
D	1-2 GHz	L	15-30 cm
E	2-3 GHz	S	10-15 cm
F	3-4 GHz	S	7.5-10 cm
G	4-6 GHz	C	5-7.5 cm
H	6-8 GHz	X	3.75-5 cm
I	8-10 GHz	X	3-3.75 cm
J	10-20 GHz	X-Ku	1.5-3 cm
K	20-40 GHz	K-Ka	7.5 mm-1.5 cm
L	40-60 GHz	V	5-7.5 mm
M	60-100 GHz	W	3-5 mm

COMMUNICATIONS BANDS

Frequency	Band	Frequency
ELF	Extra Low Frequency	0-3 kHz
VLF	Very Low Frequency	3-30 kHz
LF	Low Frequency	30-300 kHz
MF	Medium Frequency	300 kHz-3 MHz
HF	High Frequency	3-30 MHz
VHF	Very High Frequency	30-300 MHz
UHF	Ultra High Frequency	300 MHz-3 GHz
SHF	Super High Frequency	3-30 GHz
EHF	Extremely High Frequency	30-300 GHz

AIRCRAFT CARRIERS
(CVN/CV/CVG/CVS/CVSG)

CLEMENCEAU



Clemenceau (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: France
Type: *Porte avions* PA; medium aircraft carrier (CV)

Class: CLEMENCEAU

Active: 2

Displacement:
standard: 27,307 t
full load: 32,780 t
Length: oa 265 m (869.4 ft); wl 238.0 m (781 ft)
Beam: oa 51.2 m (168 ft); hull 31.7 m (104 ft)
Draught: 8.6 m (28.2 ft)

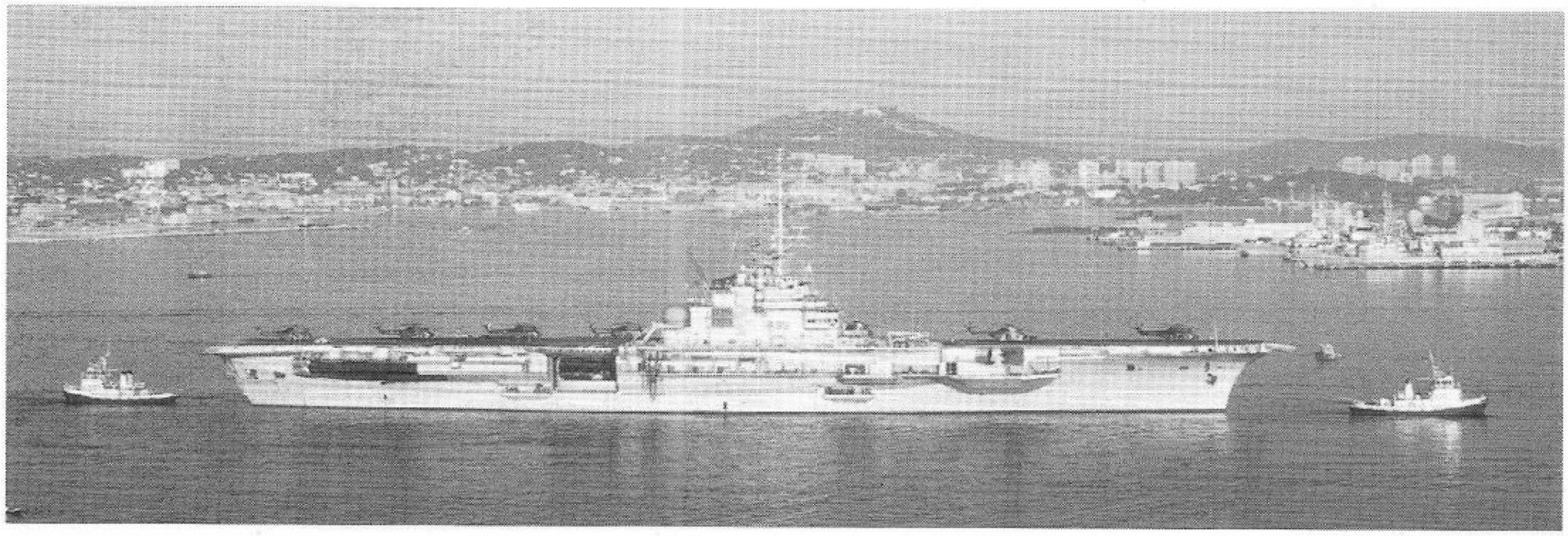
Speed: 32 kts
Range: 7,500 n miles at 18 kts; 4,800 n miles at 24 kts; 3,500 n miles at full power

Complement: 1,017 (47 officers) plus 672 aircrew

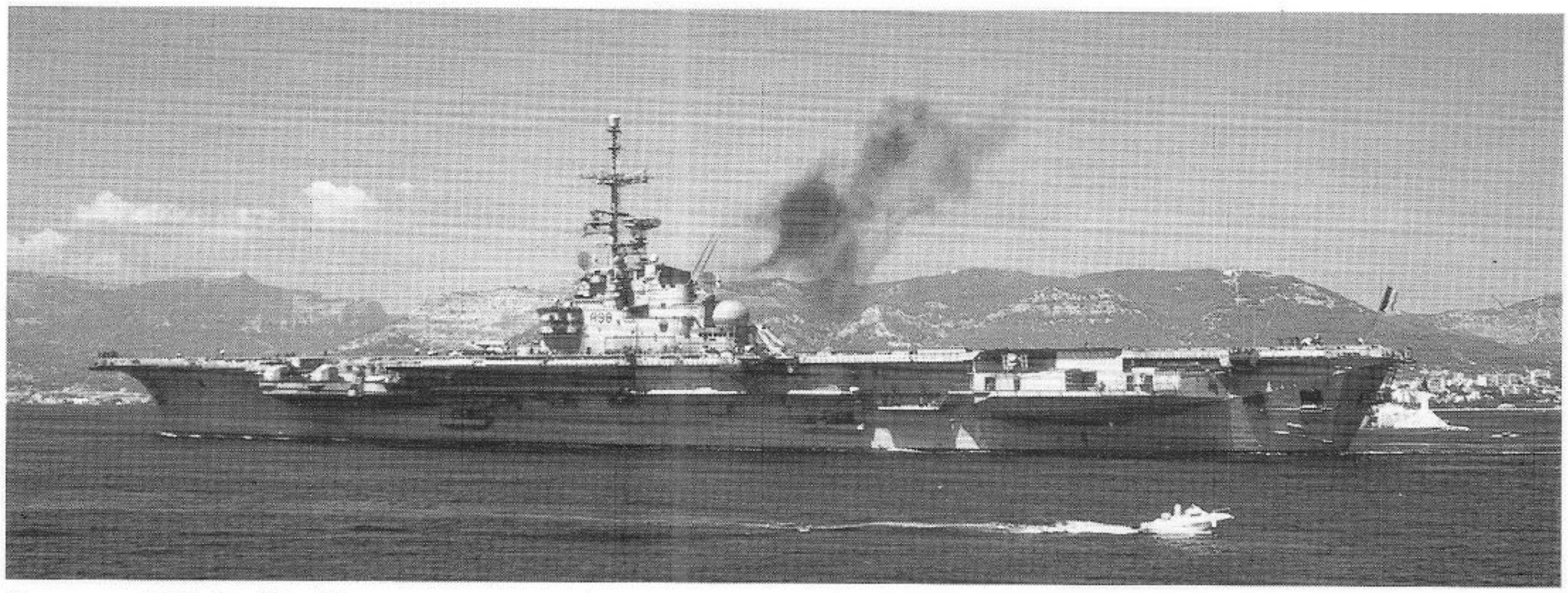
SHIPS

CLEMENCEAU (R 98)
Builder Naval Dockyard, Brest, France
Laid down 15 Sep 1955
Launched 21 Dec 1957
Commissioned 22 Nov 1961

FOCH (R 99)
Builder Chantiers de l'Atlantique, St. Nazaire, France
Laid down Feb 1957
Launched 28 Jul 1960
Commissioned 15 Jul 1963



Foch *(R 99) returns to port with a load of Army Puma helicopters, reflecting the increased use of joint forces.* Foch *has been refitted to enable it to handle Rafale M* (Jane's/H M Steele)



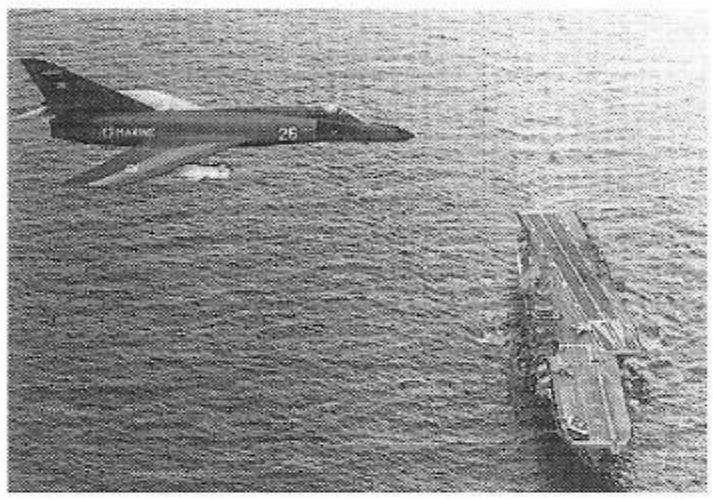
Clemenceau *(R 98), the older of the two current carriers, was commissioned in 1961 and will pay off in 1997* (Jane's/H M Steele)

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Thomson-CSF Crotale EDIR

Four Thomson-CSF Crotale EDIR octuple launchers; 18 missiles per magazine. Each complete system comprises a combined director and missile-launching mounting, a fire-control room with supporting electronics and a supervising console in the combat information centre. There is also a missile handling and storage system. The system obtains search information from the DRBV 23B radar, while the director's own sensors are a two-axis stabilised Castor radar antenna, a missile guidance antenna, an infra-red localiser and a TV for low-level tracking. The localiser is designated *Ecartometrie Differentielle Infra-Rouge* (EDIR), while the R440N missile, which attains a speed of Mach 2.3 some 2.5 seconds after launch, can manoeuvre at up to 25 *g* in each axis. System reaction time from target acquisition to launch is a minimum of 4.5 seconds and an average of 6 seconds and maximum range against a helicopter-type target is 7.02 n miles (13 km), but against high-speed manoeuvring targets such as fixed-wing aircraft or missiles it is between 3.5 and 5.7 n miles (6.5 and 10.5 km). The system is capable of intercepting four separate targets simultaneously and there are two types of fuze: infra-red (V3N) and RF (V3S). The J-band monopulse radar has a peak power of 80 kW to give it a range in excess of 8.5 n miles (16 km) and has an accuracy of 0.3 mrad in tracking and 0.1 m in missile-to-target differential deviation measurement. The RIC has a deviation measurement accuracy of 1 mrad and is designed to gather the Crotale missile for the command link.



Super Etendard strike fighter carrying an ASMP medium-range air-to-surface missile overflies Clemenceau (Aerospatiale)

Specifications

Missile R400
Length: 2.9 m (9.5 ft)
Diameter: 16 cm (6.3 in)
Wing span: 54 cm (21.25 in)
Weight: 84 kg (185.2 lb)
Speed: Mach 2.4
Warhead: 14 kg (30.9 lb)
Lethal radius: 8 m (26.25 ft)
Range: 700 m to 13 km (766 to 14,230 yd)
Altitude: 4,000 m (13,120 ft)

Launcher-director
Weight: 6.5 t
Traverse: 360°

Sensor
Elevation: −25 to +85°
Radial velocity: 2 rad/s azimuth; 3 rad/s elevation

Mounting
Radial velocity: 1.5 rad/s azimuth; 1 rad/s elevation
Electrical power requirements: 440 V 60 Hz, 115 V 60 Hz, 115 V 400 Hz

Manufacturer/Contractor

Thomson-CSF, France.

Matra Sadral

Foch only. Two sextuple launchers for Matra Sadral *(Système d'Auto Défense Raprochée Anti-aérienne Légère)* point-defence missile systems. Role Anti-sea-skimmer, able to engage targets down to 3 m (10 ft) above sea level.

Specifications

Missile
Guidance: IR homing
Range: 4 km (2.2 n miles)
Warhead: 3 kg (1,500 tungsten balls)

Manufacturer/Contractor

Matra, France.

GUNS

DCN (Creusot-Loire) 100 mm (3.9 in), 55-calibre, Modèle 1953 automatic guns

Four DCN (Creusot-Loire) 100 mm (3.9 in), 55-calibre, Modèle 1953 automatic guns. The mounting consists of a gun mount weighing 13.5 t, an ammunition supply and replenishment system, together with ancillary and control equipment. The gun uses an analogue fire-control system and requires two gunners to be on the mount.

Specifications

Calibre: 100 mm (3.9 in)
Barrel length: 55 calibres
Muzzle velocity: 870 m/s (2,790 ft/s)
Traverse: 360° at 50°/s
Elevation: −15 to +80° at 35°/s
Mounting weight: 17.3 t
Turret dimensions:
  height: 3.14 m (10.3 ft)
  breadth: 4.04 m (13.25 ft)
Crew: 2 (loaders)
Range:
  surface targets: 9.15 n miles (17 km)
  air targets: 6,000 m (19,685 ft)
Rate of fire: 10, 40, 90 rds/min
Barrel life: <3,000 rds
Ammunition: 13.5 kg (29.8 lb) (projectile)
Power requirements: 440 V, 3-phase 60 Hz; loads — 55 kVA (average); 77 kVA (max); 84 kW (peak)
Operating limits:
  roll: ±25° at 26°/s
  pitch: ±6° at 6°/s

Manufacturers/Contractors

Giat Industries, Versailles, France (system).
ECAN, Ruelle, France (gun).
CS Défense, Cortaboeuf, France (servo equipment).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thomson-CSF ARBR-17

The Thomson-CSF ARBR-17 ESM suite is a high-performance radar detection, analysis and threat warning system, covering conventional radar threat frequencies (that is, C- to J-bands). The system analyses the measured radar parameters and uses these characteristics to determine other parameters such as the radar's type and identity. There are two antenna assemblies, the first being an omnidirectional system installed on the ship's mainmast which provides initial detection and threat frequency, and carries out primary analysis. Below this are two eight-port directional antennas which provide more accurate bearing and frequency information. The antenna assemblies contain preamplifiers for improved performance.

Manufacturer/Contractor

Thomson-CSF, France.

ELECTRONIC COUNTERMEASURES (ECM)

ARBB-33

One ARBB-33 jammer has a multiple threat capability and is able to counter up to four threats simultaneously. It can jam all modern threats: target designation radars as well as pulsed fire control radars and seeker heads. It has a wide range of jamming modes: continuous noise, pulsed noise, cover pulse jamming, synchronous and asynchronous false echoes, and range gate pull off. The system can be alerted initially by a threat detection equipment, but also possesses an autonomous detection subassembly. It provides a 360° coverage in azimuth by means of electronically switched antennas for both detection and jamming, instead of the conventional directional assembly, in order to allow faster reaction time in any direction.

Specifications

Frequency coverage: H-, I- and J-bands
Azimuth coverage: 2 sectors of 180°
Reaction time: <0.5 s
Output power: <100 kW
Threat handling: 2 simultaneously
Detection sensitivity: <−50 dBm
Bearing accuracy: >5° RMS
Dimensions:
  canisters: 1.2 × 2.2 m
  cabinet: 1.8 × 0.6 × 0.78 m
Weights:
  canisters: 500 kg (1,102.5 lb)
  cabinet: 400 kg (882 lb)

Manufacturer/Contractor

Thomson-CSF, France.

CSEE Sagaie

Two CSEE Sagaie 10-barrelled trainable decoy launchers.

SAGAIE *(Système d'Autodéfense pour la Guerre Infra-rouge et Electromagnetique)* is a fully automatic, passive countermeasures system which provides protection against incoming missiles guided by electromagnetic (EM) or infra-red (IR) seekers, or any combination of these two, even when the missiles are attacking simultaneously over the entire horizon. SAGAIE is fully automatic from the reception of a missile threat alarm originating from any of the surveillance systems (radar, IR, optical or ESM) and optimises the use of decoys in a very short reaction time. The equipment can be used alone (confusion and distraction) or jointly with a jammer (dilution, substitution after concealment, substitution after deception) by firing substitution decoys. The installation in *Clemenceau* and *Foch* comprises: four fully stabilised launchers loaded with 10 rockets in 30 kg (66.1 lb) containers and trainable in azimuth and elevation; two servo units; two aiming and maintenance units; and a processing unit which computes the rocket launching sequence and provides information for the supervision unit; a supervision unit with controls and status displays; and an interface unit which provides for operation with any tactical data or target designation system. SAGAIE fires either EM or IR decoy rocket-type ammunition or both.

Specifications

Range:
  chaff: 8 km (4.3 n miles)
  IR flares: 3 km (1.6 n miles)

Manufacturer/Contractor

CS Défense, Courtaboeuf, France.

Dassault LAD

Dassault LAD (Leurre Actif Décale) is an offboard decoy system designed to counter radar-guided anti-ship missiles, consisting of an intelligent electronic decoy round, a standard 130 mm (5.1 in) calibre

multibarrelled launcher and a microprocessor-based fire control unit. The system interfaces with the ship sensors to give fully automatic, semi-automatic or manual activation of the decoy round, which consists of a low *g* rocket, a parachute, a transmitter, a receiver and antennas, control electronics and a battery source.

Specifications
Length: 900 mm (35.4 in)
Diameter: 127 mm (5 in)
Deployment time: >10 s
Jamming time: <3 min
Power consumption: 2 kW

Manufacturer/Contractor
Dassault Electronique, Saint-Cloud, France.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

SENIT 2 tactical data automation system

SENIT 2 *(Système d'Exploitation Navale des Informations Tactiques)* was developed from SENIT 1 and was designed to compile a tactical picture around major warships and task groups using onboard and offboard sensors, utilising a mainframe computer and CS-1 software language. The general purpose computer is designed to store tactical situation data and transmit the relevant data to the display systems and, through weapon control consoles, to weapons. In addition to running the display systems the computer transmits tactical situation data via communications links (Link 11 and Link 14) to other elements of the task group. SENIT 2 has three computers, which are versions of the Paramax CP-642 (US designation AN/UYK-20), a 32-bit processor with a 96 k memory which is capable of 125 kops. They are supported by a control desk, a magnetic tape unit and a paper tape unit. These three systems are capable of monitoring 128 tracks simultaneously. SENIT 2 uses Hughes AN/UYA-4 consoles which were manufactured under licence by Thomson-CSF, have a 30 cm PPI display for the presentation of raw video data and also for the presentation of a synthetic picture. Each display can present up to 70 tracks and 96 symbols together with a marker and a close control symbol as well as alphanumeric data. The SENIT 2 systems in the 'Clemenceau' class carriers have nine consoles and a V6 TER horizontal display.

Rafale M prototype M01 takes off from Foch *using the 'mini ski ramp'. This unique device is 10 m (32.8 ft) long and 4.2 m (13.8 ft) wide, with a positive angle of 1.5° and combines with a nosewheel extending device to enable the aircraft to take off successfully* (Dassault/Aviaplans)

Manufacturer/Contractor
DCN, Paris, France.

AIDCOMER command support system

AIDCOMER *(Aide du Commandement à la Mer)* is a shipborne command support system for use by the Officer in Tactical Command (OTC) and his staff. It interfaces with the SENIT system and communicates, via datalinks, with SYCOM 2, which is the shore-based component equipping both naval and joint command centres ashore. AIDCOMER manages and displays the recognised maritime picture and operational areas, and incorporates tactical decision making aids. It also provides access to all available data and enables messages to be transmitted and received.

Rafale M prototype conducting deck landing trials on Foch. *Rafale Ms will embark in* Foch *for several years until the problem of the second carrier is resolved* (Dassault/Aviaplans)

Manufacturer/Contractor
DCN, Paris, France.

RADARS

Type	DRBV 23B	DRBI 10	DRBV 15	1226	DRBC 32B
Maker	Thomson-CSF	Thomson-CSF	Thomson-CSF	Racal-Decca	Thomson-CSF
Role	Air search	Height-finder	Air/surface search	Surface search	Fire control
Band	L	S	S	X	I/J
Beam	2.5 × 50°	2 × 2°	1.65 × 8° csc² (to 45°)	1.2°	1.5°
Peak power	2,000 kW	2,000 kW	60 kW	25 kW	80 kW
Gain		37 dB	29.5 dB	30 dB	—
Pulsewidth	2.5 µs	4 µs	5.5/12 µs	0.05/0.25/1 µs	4 µs
PRF	450 pps	500 pps	2,200/1,100 pps	—	—
Scan rate	7.5/15 rpm	Horizontal — 4 rpm Vertical — 800 scans/min	12/24 rpm	28 rpm	—
Typical range	160 n miles	100-140 n miles against 'fighter' target	110 km against 2 m² target	—	15 km against 0.1 m² target

SONAR

AN/SQS-505 sonar

The Canadian Westinghouse AN/SQS-505 sonar is a hull-mounted 7 kHz medium-size search and attack sonar, one of which is fitted in each carrier. The AN/SQS-505 can be used in direct communication with a digital computer, either for the transfer of range and bearing information or for assistance to the operator in detection and tracking. It is a deep water, omnidirectional, surveillance system, but is also able to operate in a directional mode that can maintain search ability while tracking defined targets. Three selectable frequencies are available so that several ships can survey an area in close proximity without cross-talk. In high sea states leading to excessive roll and pitch of the ship, the AN/SQS-505 utilises transmit beam stabilisation, which delays transmission until near optimum roll and submergence conditions prevail, thereby minimising chances of the target being missed altogether.

Specifications
Coverage: 360° (azimuth)
Range: 183-3,000 m (200-3,200 yd)
Doppler range: ±40 kts (7.2 kHz)
Displays: Range (A Scan); Bearing (B Scan)
Doppler frequencies: 6.4, 7.2 and 8.0 kHz
Source levels: From 224.233 dB/µPa/m (transmission mode dependent)
Initial detection: 12 ping history of returns
Bearing accuracy: 1° RMS

Range accuracy: ±1% range reading
Transmission modes: Omni, TRDT, DT, ASPECT
Power level: High and low (10 dB reduction)

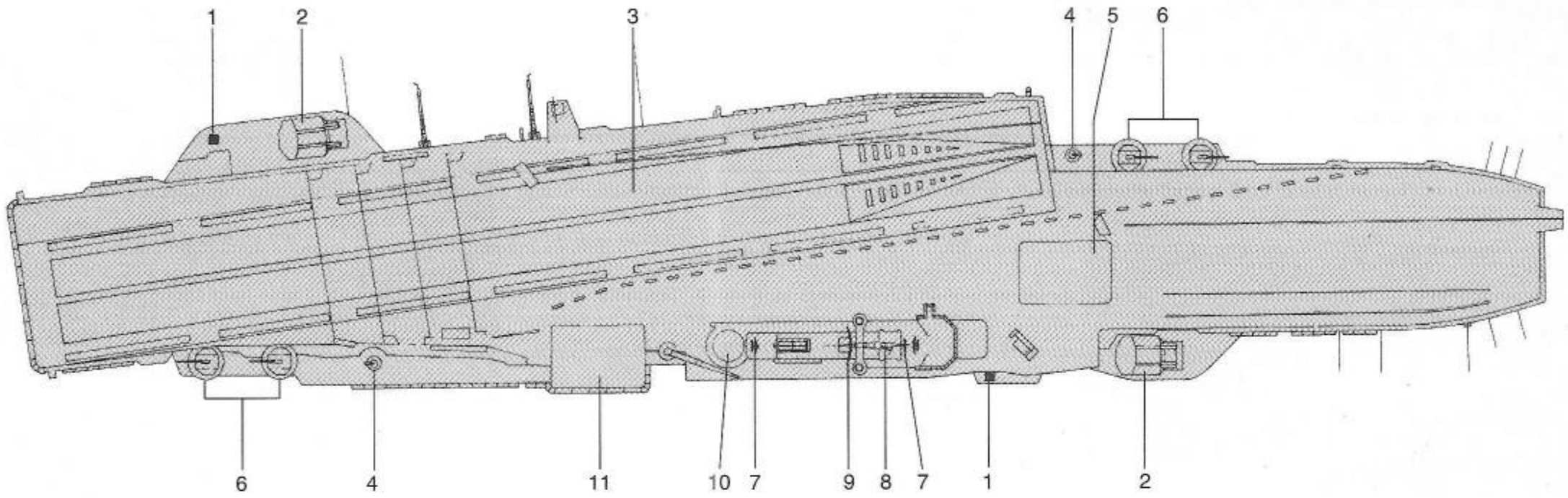
Manufacturer/Contractor
Westinghouse Canada Inc, Burlington, Ontario, Canada.

COMMUNICATIONS AND DATALINKS

These two carriers are fitted with the normal range of HF, VHF and UHF communications for ship-to-ship, ship-to-air and ship-to-shore links. Specific communications facilities include:

Link 11, Link 14 and Link 16 datalinks
JMCIS
Syracuse 1 Satcom
Inmarsat
Fleet Satcom.

AVIATION



Clemenceau (Ian Sturton)
1 *CSEE Sagaie decoy launcher* **2** *Octuple Thomson-CSF Crotale SAM launcher* **3** *Flight deck* **4** *Thomson-CSF DRBC 32B* **5** *Forward elevator* **6** *DCN 100 mm (3.9 in)/55 Modèle 1953 automatic gun* **7** *DRBI 10 air/surface search radar* **8** *DRBV 15 air/surface search radar* **9** *Thomson-CSF DRBV 23 B air search radar* **10** *NRBA 51 landing approach control radar* **11** *Deck-edge elevator*

AVIATION FACILITIES

Specifications
Flight deck: 165.5 × 29.5 m (543 × 96.8 ft)
Angled deck: 8°
Hangar: 180 oa (152 usable) × 24 × 7 m (590 (498) × 78.7 × 23 ft)
Elevators: 2—16 × 10.97 m (52.5 × 36 ft), each 20 t capacity
Catapults: 2 Mitchell-Brown Mk BS 5 steam catapults; capacity, 20 t aircraft at 110 kts
Flight deck letters: F = Foch, U = Clemenceau

Air Wing
See *Aircraft* Section for full details.

FIXED-WING AIRCRAFT

Dassault Super Etendard M
18 Dassault Super Etendard Modernisée (Super Etendard M), single-seat, strike fighters.

Specifications
Wing span: 9.60 m (31.5 ft)
Length overall: 14.31 m (46.96 ft)
Height overall: 3.86 m (12.66 ft)
Weights, mission take-off: 9,450-12,000 kg (20,833-26,455 lb)
Max speed at low level: 637 kts (1,180 km/h)
Max speed at altitude: approx Mach 1
Service ceiling: 13,700 m (45,000 ft)
Radius of action with AM39: 460 n miles (850 km)
Engine: 1 SNECMA Atar 8K-50 non-afterburning turbojet; 49 kN (11,025 lb st)
Accommodation: 1 (pilot)

Manufacturer/Contractor
Dassault Aviation, France.

Dassault Etendard IVP
Four Dassault Etendard IVP, single-seat, supersonic, photographic reconnaissance aircraft.

Specifications
Wing span: 9.60 m (31.5 ft)
Length overall: 14.50 m (47.58 ft)
Height overall: 3.85 m (12.66 ft)
Max take-off weight: 10,200 kg (22,486 lb)
Max level speed: Mach 1.3
Service ceiling: 10,668 m (35,000 ft)
Range: 750 n miles (1,75 h or 2.25 h with external tanks)
Engine: 1 SNECMA Atar 8 turbojet, rated at 9,700 lb st
Accommodation: 1 (pilot)

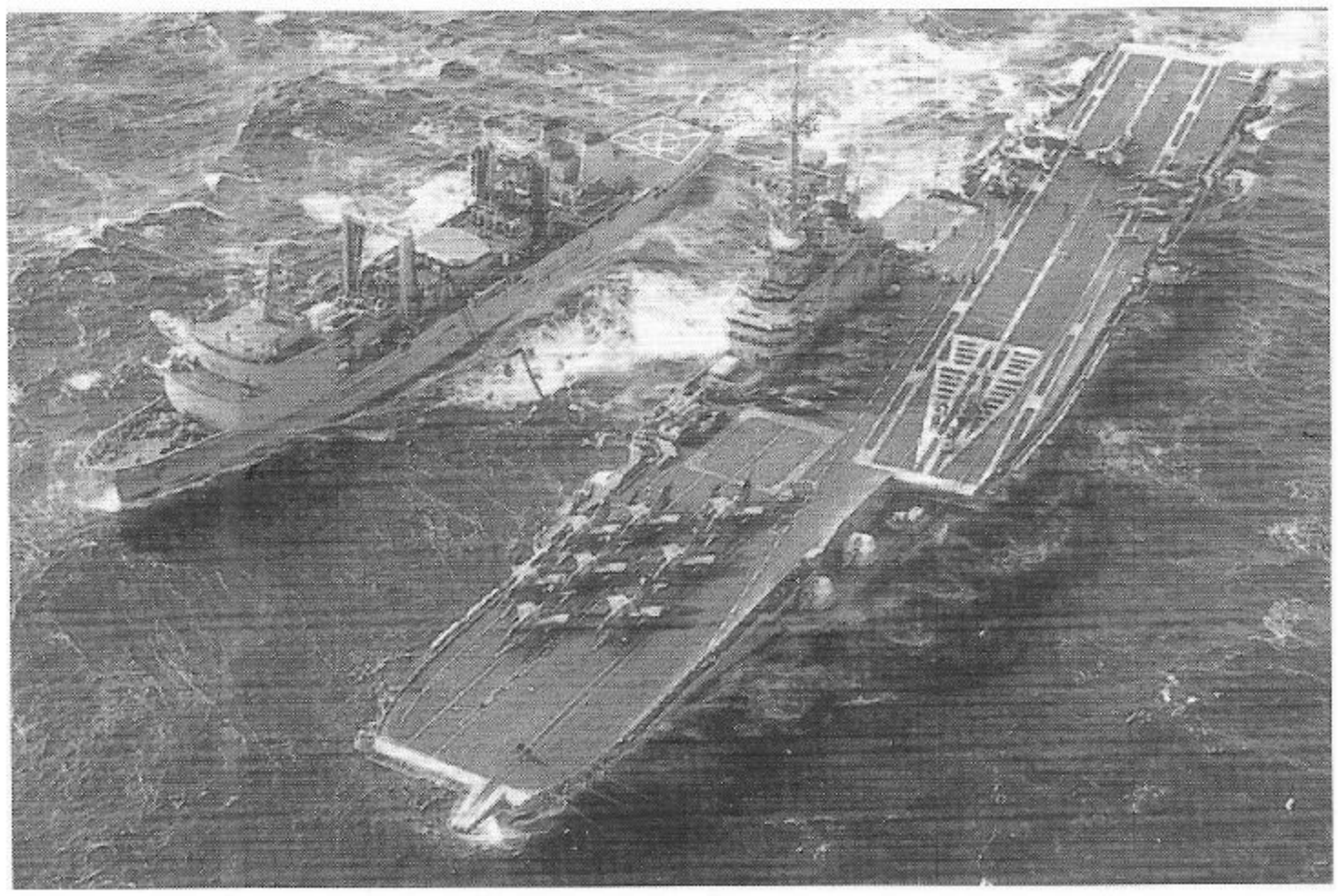
Manufacturer/Contractor
Dassault Aviation, France.

Ling-Temco-Vought Crusader
Eight Ling-Temco-Vought F-8P (F-8E(FN)) Crusader, single-seat, supersonic, all-weather, carrier-based, interceptor fighter.

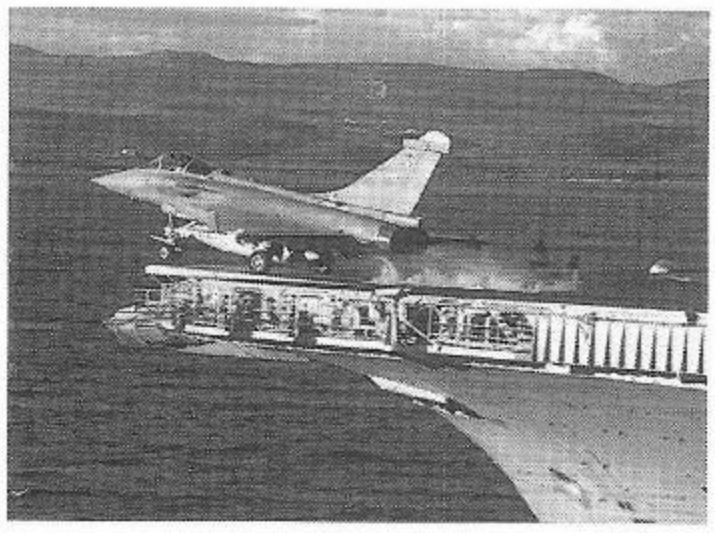
Specifications
Wing span: 10.87 m (35.66 ft)
Length overall: 16.61 m (54.5 ft)
Height overall: 4.80 m (15.75 ft)
Max take-off weight: 15,420 kg (34,000 lb)
Max level speed: Nearly Mach 2
Service ceiling: 15,240 m (50,000 ft)
Combat radius: 520 n miles (965 km)
Engine: 1 Pratt & Whitney J57 P20A afterburning turbojet, rated at 10,700 lb st and 18,000 lb st with afterburner
Accommodation: 1 (pilot)

Dassault (Breguet) BR 1050 Alizé
Six Dassault (Breguet) BR 1050 Alizé, turboprop-powered, surveillance/anti-submarine aircraft.

Specifications
Wing span: 15.60 m (51.17 ft)
Length overall: 13.86 m (45.46 ft)
Height overall: 5.00 m (16.42 ft)
Max take-off weight: 8,200 kg (18,078 lb)
Max speed at sea level: 248 kts (460 km/h)
Max speed at 3,050 m (10,000 ft): 280 kts (518 km/h)
Ceiling: 8,000 m (26,250 ft)
Range: 1,349 n miles (2,500 km)
Normal endurance: 5 h 10 min
Engine: 1 Rolls-Royce Dart RDa 7 Mk 21 turboprop, with Rotol four-bladed variable-pitch propeller



Foch, *with most of its air wing on deck. The Super Etendards and Crusaders will be replaced by Rafale Ms, but the carrier itself is likely to be retired within five years. A variety of Army helicopters can also be carried.* (SIRPA)



Rafale M prototype M02 takes off over Foch's *mini ski ramp carrying a large container on the under-fuselage pylon, possibly simulating a nuclear weapon* (Dassault/Aviaplans)

Accommodation: 3 (pilot, forward radar operator, rear radar operator)

Manufacturer/Contractor
Dassault Aviation, France.

HELICOPTERS

Eurocopter AS 365MA Panther
Two Eurocopter AS 365MA Panther light liaison, search and rescue, and planeguard helicopters.

Specifications
Rotor diameter: 13.29 m (43.6 ft)
Fuselage length: 11.41 m (37.43 ft)
Height to rotor head: 4.0 m (13.12 ft)
Weight empty: 2,262 kg (4,987 lb)
Max take-off weight: 4,250 kg (9,370 lb)
Max slung load: 1,600 kg (3,527 lb)
Max speed (never-exceed): 160 kts (296 km/h)
Max cruising speed at sea level: 148 kts (274 km/h)
Max rate of climb at sea level: 420 m (1,380 ft)/min
Hovering ceiling (in ground effect): 2,600 m (8,530 ft)
Hovering ceiling (out of ground effect): 1,860 m (6,102 ft)
Engines: 2 Turbomeca Ariel 1M1 turboshafts
  take-off: 558 kW (749 shp)
  continuous: 487 kW (653 shp)
Accommodation: 2-man crew (cabin can hold 10 passengers)

Manufacturer/Contractor
Eurocopter SA, Paris, France.

PROPULSION

Specifications
System: Steam turbines
Main machinery: Chantiers de l'Atlantique; 6 boilers
Operating pressure: 45 kg/cm² (640 psi)
Operating temperature: 450°C (840°F);
Turbines:
  Clemenceau: 2 Parsons
  Foch: GEC Alsthom
Power output: 126,000 hp(m) (93 MW)
Shafts: 2
Oil fuel capacity: 3,720 t

FURTHER INFORMATION

PROGRAMME

The French Navy operated four aircraft carriers in the immediate postwar years. *Dixmude* and *Arromanches,* both ex-British, served until 1960 and 1974, respectively, while two US Navy 'Independence' class carriers were operated on loan: *La Fayette* from 1950 to 1963 and *Bois Belleau* from 1953 to 1960. These were all replaced by the two 'Clemenceau' class aircraft carriers, which were the first to be designed and built from the keel up in France (France's first carrier, *Bearn,* completed in 1927, was based on the incomplete hull of a 'Normandie' class battleship). Designated project PA 54 (PA = porte avions (aircraft carrier). *Clemenceau* was authorised in 1953 and *Foch* in 1955, entering service in 1961 and 1963, respectively. The design was conventional, but incorporated all the carrier developments of the early 1950s, such as an angled flight deck, steam catapult and deck-landing mirrors.

MODERNISATION

Clemenceau was refitted in 1978 to enable it to accommodate Super Etendard aircraft and AN-52 tactical nuclear weapons and this was followed by *Foch* in 1980-81. A major refit for *Clemenceau* followed in 1985/86. The armament was altered by replacing four 100 mm guns by two Crotale EDIR, while aviation facilities were improved by fitting new aircraft lifts and catapults with increased capacities. Electronic upgrades included modernisation of communications (including the introduction of Syracuse 1 Satcom) and electronics, fitting of Sagaie, new long-range air warning radar and passive radar detection system, and modernised combat data system. The boilers were also retubed and the engines given a major overhaul. A similar refit for *Foch* followed in 1987-88, but this also included a trial installation of CSEE Dallas (Deck Approach and Landing Laser System), and the capability to accommodate ASMP nuclear missiles for the Super Etendard.

In 1992/93 *Foch* was fitted with a removable 1.5° mini ski-jump (10 × 4.2 × 0.2 m) on the forward catapult as well as a nose-gear launch device and the landing mirror was moved forward. The SENIT 2 combat system was also slightly modified. *Clemenceau* has received similar modifications (but to a lesser extent).

In 1995/96 more work was done on *Foch* to enable the carrier to operate Rafale M aircraft permanently, which included a wider, foldable mini ski-jump being fitted to both catapults and enlarged jet deflectors, which led to a reduction in the area of the forward lift. *Foch* also received two Sadral SAM systems in 1995/96.

DESIGN

The flight deck, island superstructure and the machinery spaces and magazines are all armour plated. There are three bridges: flag, command and aviation. *Clemenceau* mainmast was shortened in 1990.

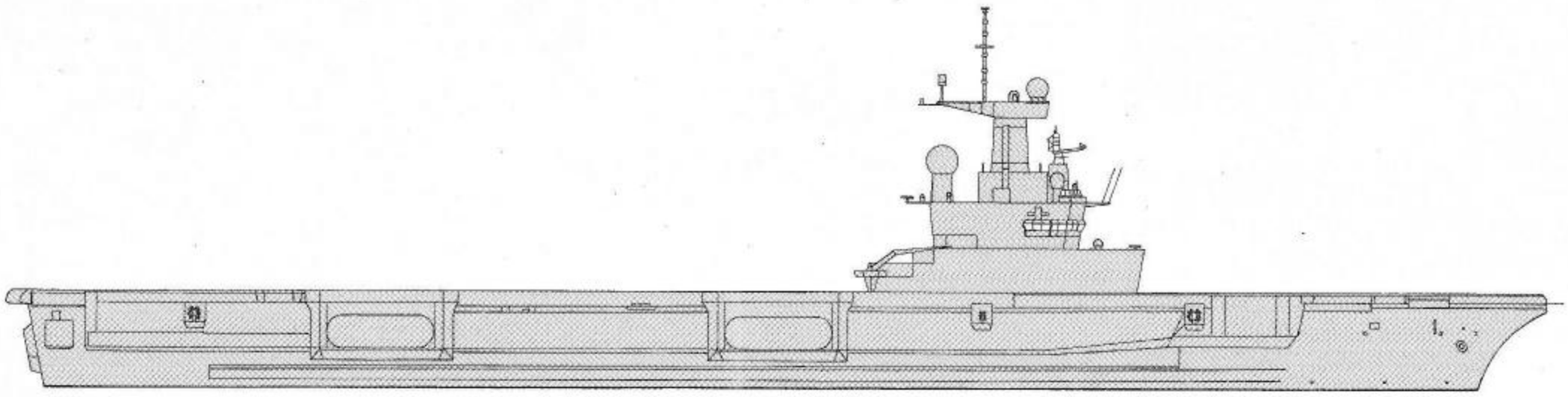
OPERATIONAL

The aircraft complement for the helicopter carrier role includes between 30 and 40 with a mixture of Super Frelon, Lynx, Super Puma, Puma and Gazelle (the last three types being army owned). Crusaders refitted to stay in service until replaced by Rafale. Deck trials of Rafale M aircraft were carried out in *Foch* in April/May 1993, and again in 1994. Hawkeye AEW aircraft may be embarked in *Foch* in due course.

OPERATIONAL LIFE

Under current plans, *Clemenceau* will pay off in 1997, although *Charles de Gaulle* will not enter service until 1999. It is also planned that *Foch* will pay off in 2004. One option would be to run *Foch* on, but, having entered service in 1963, the ship will then be 40 years old.

CHARLES DE GAULLE



Charles De Gaulle (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: France
Type: *Porte-Avions Nucléaires* PAN; aircraft carrier, nuclear-powered (CVN)
Designation: R 91

Class: CHARLES DE GAULLE (PAN 01)

Active: 0
Building: 1
Proposed: 1

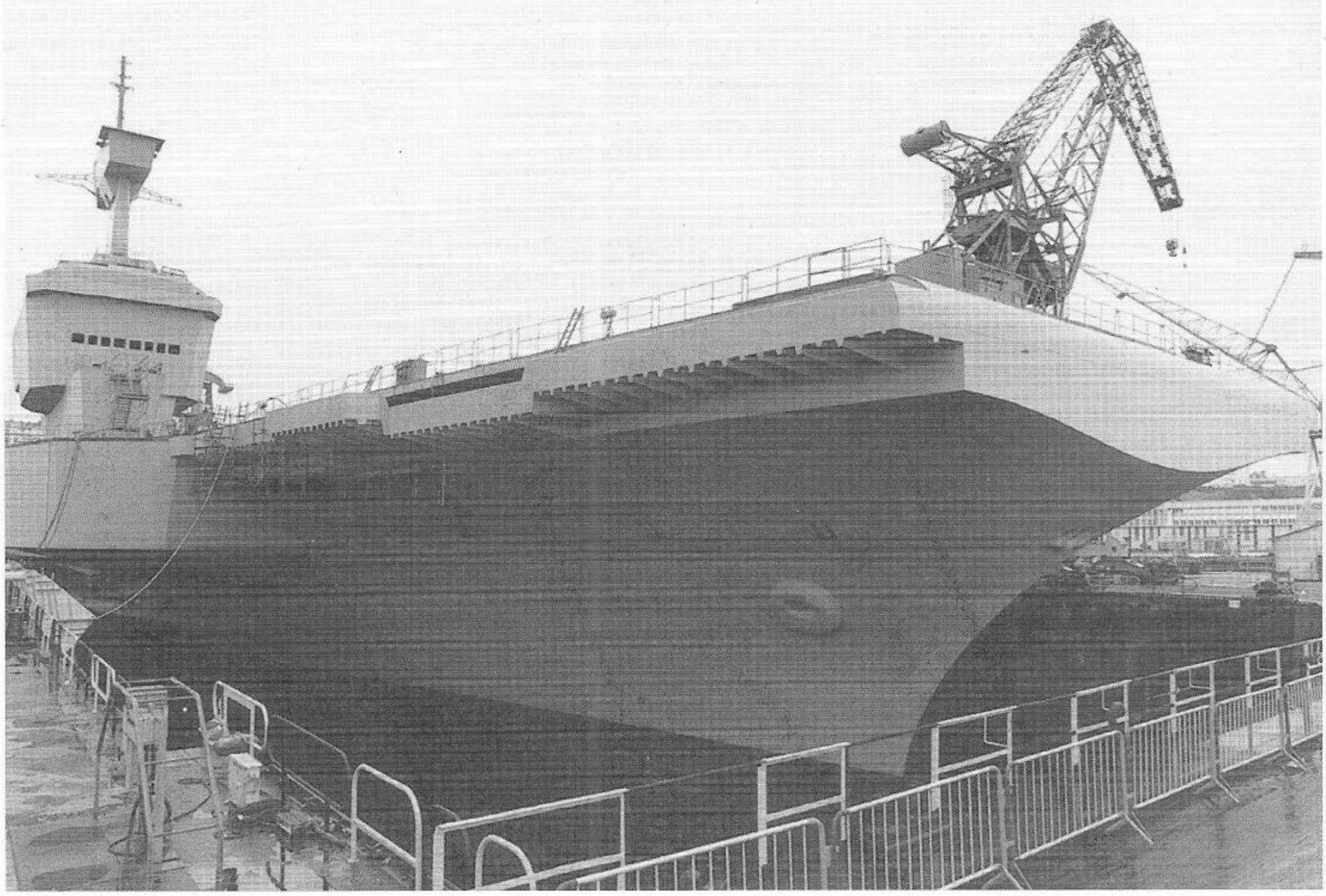
Displacement:
standard: 36,600 t
full load: 39,680 t
Length: oa 261.5 m (857.7 ft); wl 238 m (780.8 ft)
Beam: oa 64.4 (211.3 ft); wl 31.5 m (103.3 ft)
Draught: 8.5 m (27.8 ft)

Speed: 27 kts
Endurance: 5 years at 25 kts

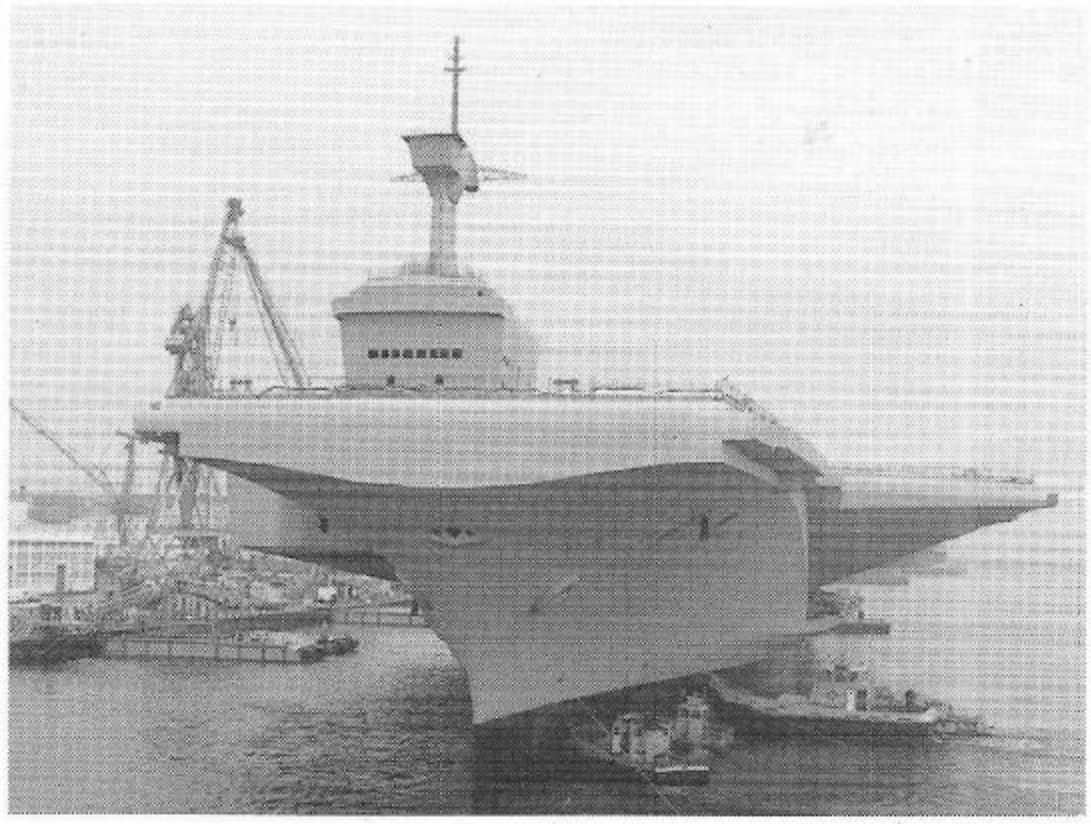
Complement: 1,150 ship's company, plus 550 air-crew, plus 50 Flag staff; (accommodation for 1,950) (plus (temporarily) 800 marines)

SHIPS

CHARLES DE GAULLE (R 91)
Builder Brest Naval Dockyard, Brest, France
Laid down 14 Apr 1989
Launched 7 May 1994
Commissioned Dec 1999



Charles De Gaulle (DCNI)



Charles De Gaulle (DCNI)

Charles De Gaulle (DCNI)

WEAPONS SYSTEMS

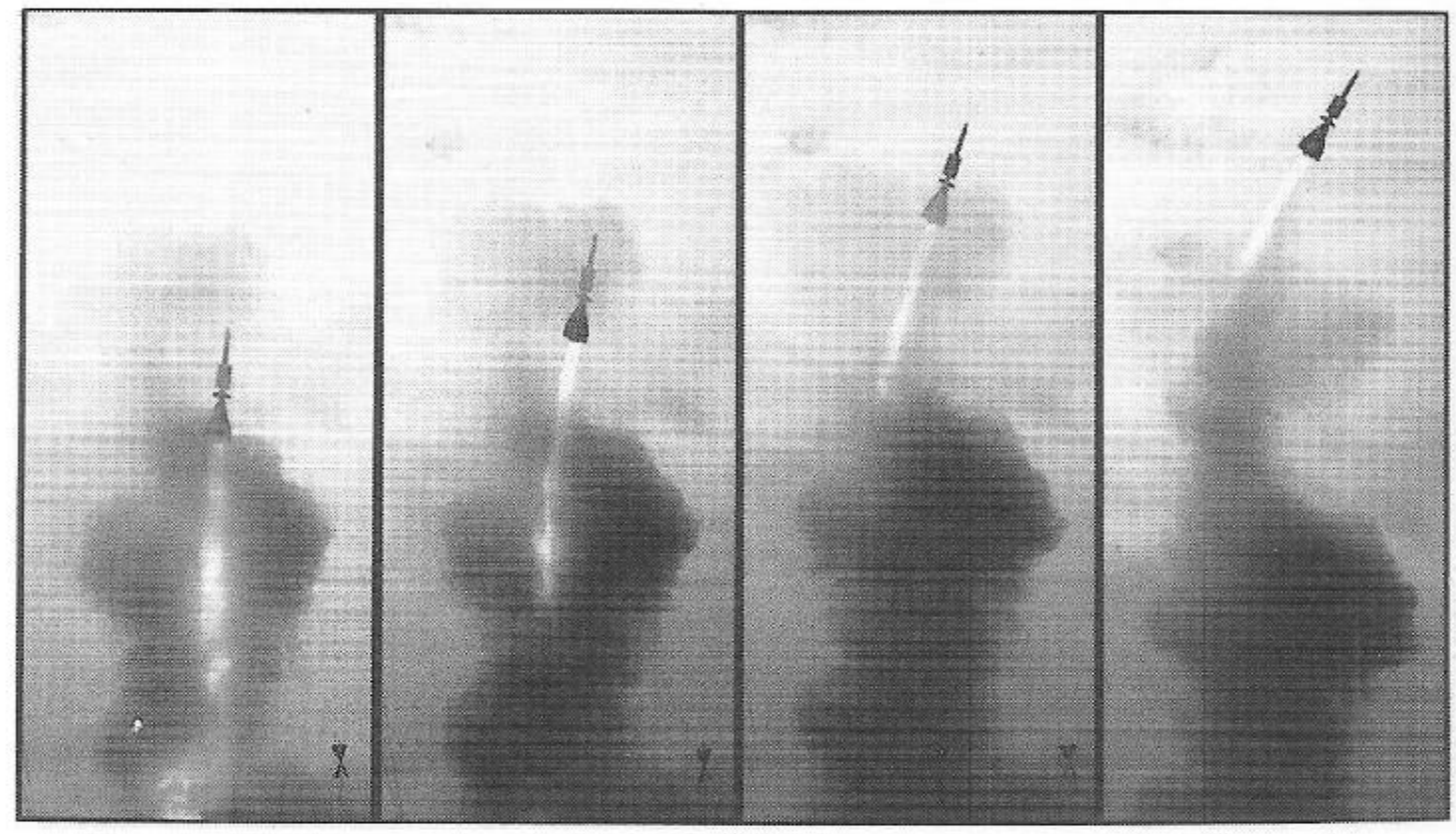
SURFACE-TO-AIR MISSILES (SAM)

EUROSAAM VLS

Four EUROSAAM VLS octuple launchers for Aerospatiale ASTER 15 anti-missile system with inertial guidance and mid-course update. Guidance is supported by Arabel radar (see below).

Specifications
Length: 4.34 m (14 ft 3 in)
Diameter: 0.18 m (4.9 ft)
Speed: Mach 2.5
Homing: Active radar
Range: 15 km (8.1 n miles)
Manoeuvrability: 15 *g*
Weight: 298 kg (657 lb)
Warhead: 13 kg (28.7 lb)

Manufacturers/Contractors
Eurosam GIE.
Aerospatiale, France.



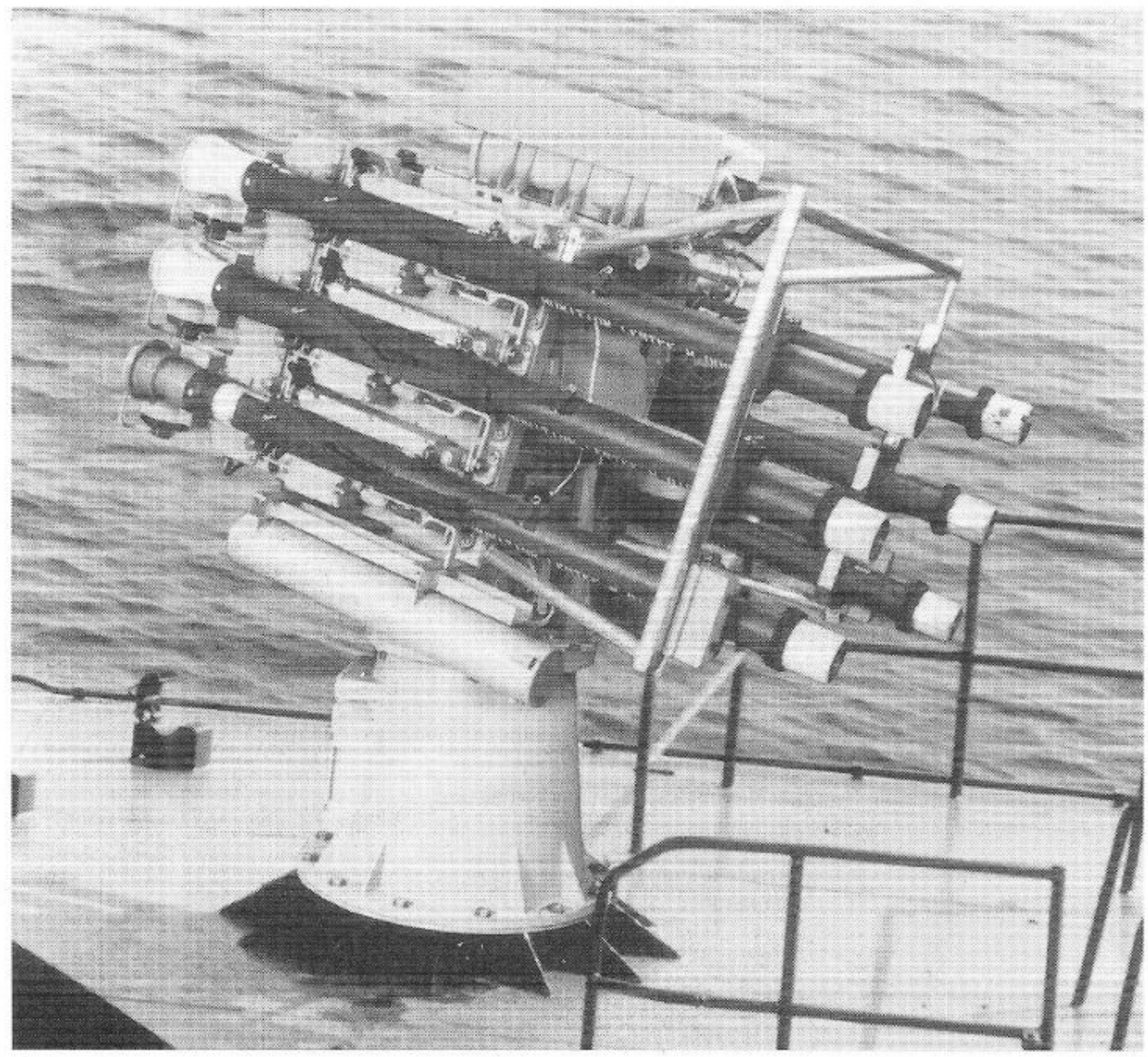
ASTER 15 (CEL)

Matra Sadral

Two sextuple launchers for Matra Sadral *(Système d'Auto Défense Raprochée Anti-aérienne Légère)* point-defence missile systems. The missile is the Mistral.

Specifications
Guidance: IR homing
Range: 4 km (2.2 n miles)
Warhead: 3 kg (1,500 tungsten balls)
Role: Anti-sea-skimmer, able to engage targets down to 3 m (10 ft) above sea level.

Manfacturer/Contractor
Matra Défense, France.



Sadral (Matra)

GUNS

Giat 20 mm

Eight Giat 20 mm F2 TYPE A (M693) multipurpose cannon.

Specifications
Calibre: 20 mm
Barrel length: 90 calibres
Rate of fire: 720 rds/min
Muzzle velocity: 1,050-1,250 m/s
Traverse: 325°
Elevation: −15 to +80°
Mounting weight, loaded: 470 kg
Weight of shell: 0.25 kg
Crew: 2
Range: 6.75-10 km (3.5-5.5 n miles)
Power requirement: 26 V (7 A)

Manufacturer/Contractor
Giat, France.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

ARBR 17

The ARBR-17 ESM suite is a high-performance radar detection, analysis and threat warning system, covering conventional radar threat frequencies (that is, C- to J-bands). The system analyses the measured radar parameters and uses these characteristics to determine other parameters such as the radar's type and identity. There are two antenna assemblies, the first being an omnidirectional system installed on the ship's mainmast which provides initial detection and threat frequency, and carries out primary analysis. Below this are two eight-port directional antennas which provide more accurate bearing and frequency information. The antenna assemblies contain preamplifiers for improved performance.

Manufacturer/Contractor

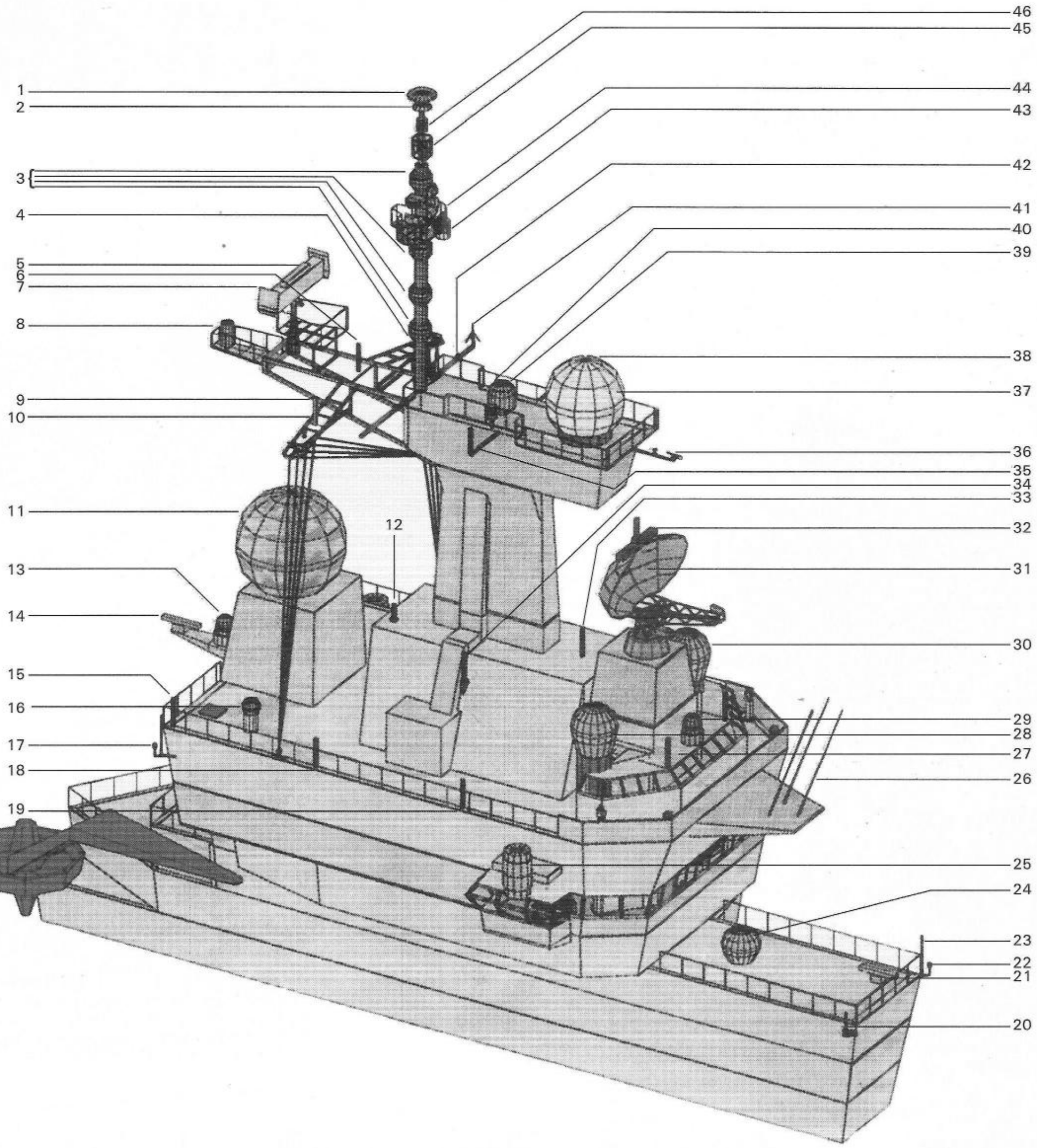
Thomson-CSF, France.

DIBV 1A VAMPIR MB

VAMPIR *(Veille Air-Mer Panoramique Infra-Rouge)* is a passive surveillance and search system for both sea- and low-level air targets. The equipment consists of a cylindrical housing carried on a vertically stabilised mount which is fixed on the ship's superstructure in a high position to ensure maximum range and freedom from obstruction. Stabilisation of the housing automatically compensates against ship motion, while the rotating optical head provides all-round scanning of the horizon. The equipment is a bispectral device operating in two distinct IR bands, thus achieving a very low false alarm rate in the presence of environmental noise. The two separate channels also enable target detection in a variety of weather conditions.

Specifications

Wavelength: 4-5 and 8-13 µm (simultaneous channels)
Field of view: 360° × 0 to +24° elevation
Detection range: <10 km for frontal attack by missile/aircraft
Target designation accuracy: 1 mrad in elevation and bearing
Sensor cooling: Joule-Thompson cycle to about 80°K
Dimensions of stabilised unit: 125 × 60 cm diameter



1 *NRBP-20A (TACAN),* **2** *JTIDS,* **3** *AN-451 (UHF),* **4** *UHF,* **5** *VHF,* **6** *IFF,* **7** *DRBV-15C,* **8** *VAMPIR,* **9** *VHF Sea/Air,* **10** *Anemometer,* **11** *DRBJ-11B,* **12** *IFF,* **13** *Jammer (?),* **14** *DRBN 34 (Decca 1229),* **15** *VHF Guerre,* **16** *Fleet Satcom,* **17** *NAVSTAR,* **18** *VHF Guerre,* **19** *VHF RITA,* **20** *VHF receive,* **21** *DRBN-34 (Decca 1229),* **22** *GPS NAVSTAR,* **23** *SYLEDIS,* **24** *Satellite TV receive,* **25** *ARBB-33,* **26** *HF rod antennas,* **27** *VHF. Radiomaritime,* **28** *Syracuse,* **29** *Jammer (?),* **30** *Syracuse,* **31** *DRBV-26D,* **32** *IFF,* **33** *AM/FM antenna,* **34** *VHF,* **35** *UHF transmission,* **36** *Anemometer,* **37** *ARABEL,* **38** *COMINT,* **39** *Satellite receive antenna,* **40** *Inmarsat,* **41** *Anemometer,* **42** *IFF,* **43** *GPS,* **44** *DR-3000,* **45** *IRP2-2 (SAIGON),* **46** *VHF*

Rotation rate: 60 rpm
Weight: 450 kg (992.2 lb)
Power: 115 V, 400 Hz, 300 VA

Manufacturer/Contractor
CS Defense, Etienne Lacroix, France.

ELECTRONIC COUNTERMEASURES (ECM)

ARBB 33 jammers
Two ARBB 33 jammers. The ARBB 33 high-performance jammer has a multiple threat capability and is able to counter up to four threats simultaneously. It can jam all modern threats: target designation radars as well as pulsed fire control radars and seeker heads. It has a wide range of jamming modes: continuous noise, pulsed noise, cover pulse jamming, synchronous and asynchronous false echoes, and range gate pull off. The system can be alerted initially by a threat detection equipment, but also possesses an autonomous detection subassembly. It provides a 360° coverage in azimuth by means of electronically switched antennas for both detection and jamming, instead of the conventional directional assembly, in order to allow faster reaction time in any direction.

Specifications
Frequency: H-, I- and J-bands
Azimuth coverage: 2 sectors of 180°
Reaction time: <0.5 s
Output power: <100 kW
Threat handling: 2 simultaneously
Detection sensitivity: Better than −50 dBm
Bearing accuracy: Better than 5° RMS
Dimensions:
canisters: 1.2 × 2.2 m
cabinet: 1.8 × 0.6 × 0.78 m
Weights:
canisters: 500 kg (1,102.5 lb)
cabinet: 400 kg (882 lb)

Manufacturer/Contractor
Dassault Electronique, France.

SAGAIE decoy launchers
Four SAGAIE 10-barrelled trainable decoy launchers. SAGAIE is a fully automatic, passive countermeasures system which provides protection against incoming missiles guided by electromagnetic (EM) or infra-red (IR) seekers, or any combination of these two, even when the missiles are attacking simultaneously over the entire horizon. SAGAIE is fully automatic from the reception of a missile threat alarm originating from any of the surveillance systems (radar, IR, optical or ESM) and optimises the use of decoys in a very short reaction time. The equipment can be used alone (confusion and distraction) or jointly with a jammer (dilution, substitution after concealment, substitution after deception) by firing substitution decoys. The installation in *Charles De Gaulle* comprises: four fully stabilised launchers trainable in azimuth and elevation; two servo units; two aiming and maintenance units; and a processing unit which computes the rocket launching sequence and provides information for the supervision unit; a supervision unit with controls and status displays; and an interface unit which provides for operation with any tactical data or target designation system. SAGAIE fires either EM or IR decoy rocket-type ammunition or both.

Specifications
Number of systems: 4
Decoys per system: 10
Range:
chaff: 8 km (4.3 n miles)
IR flares: 3 km (1.6 n miles)

Manufacturer/Contractor
CS Defense, Etienne Lacroix, France.

Dassault LAD
LAD *(Leurre Actif Décale)* is an offboard decoy system designed to counter radar-guided anti-ship missiles, consisting of an intelligent electronic decoy round, a standard 130 mm (5.1 in) calibre multibarrelled launcher and a microprocessor-based fire control unit. The system interfaces with the ship sensors to give fully automatic, semi-automatic or manual activation of the decoy round, which consists of a low *g* rocket, a parachute, a transmitter, a receiver and antennas, control electronics and a battery source.

Specifications
Length: 900 mm (35.5 in)
Diameter: 127 mm (5 in)
Deployment time: >10 s
Jamming time: <3 min
Power consumption: 2 kW

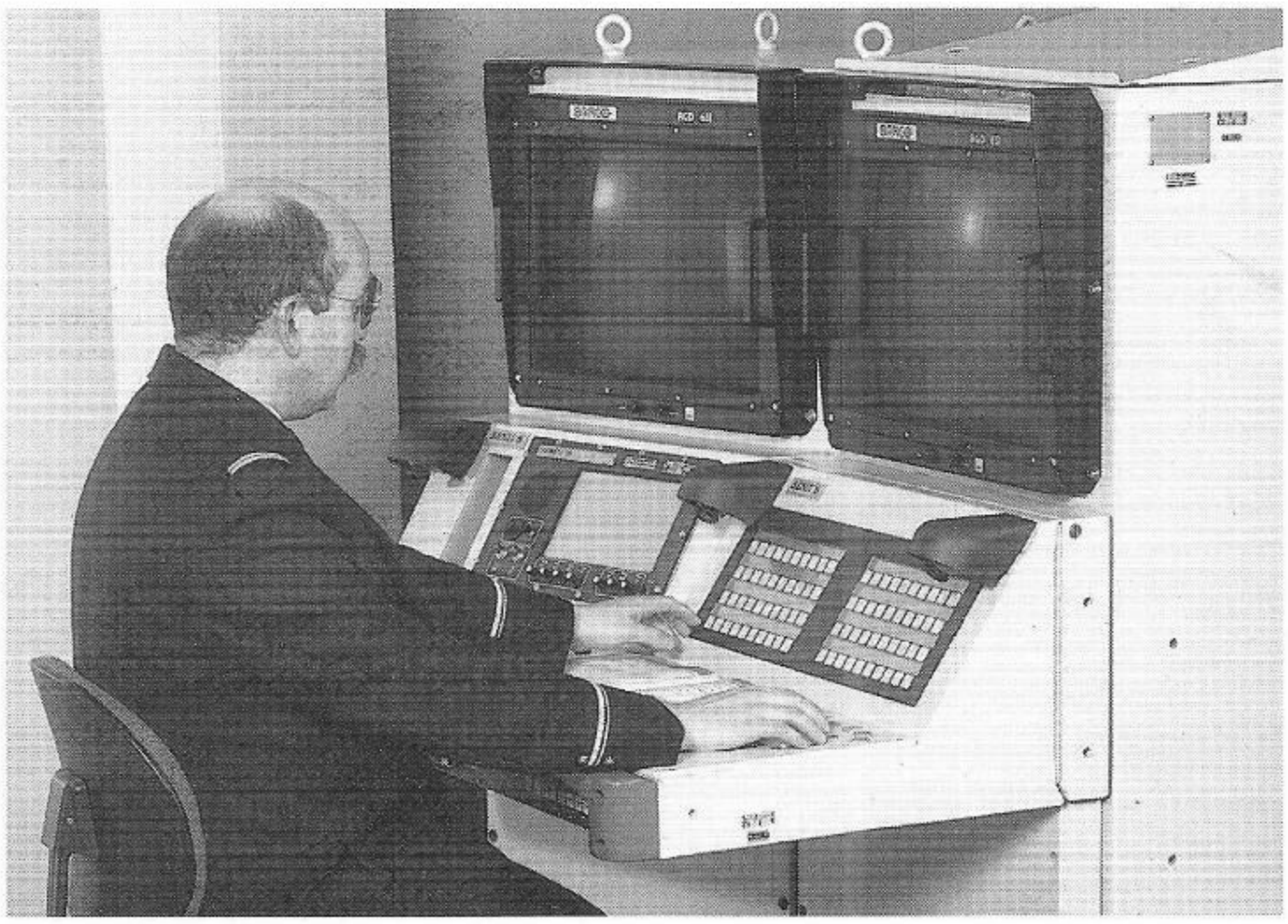
Manufacturer/Contractor
Dassault Electronique, France.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

SENIT 8
The SENIT 8 system *(Système d'Exploitation Navale des Informations Tactiques)* performs five functions: mission preparation; mission management; co-ordination of external and internal communications; and navigation. It is operated by 30 people in the combat information centre (CIC) and is required to process 2,000 tracks, perform all processing in real time, give a multithreat destruction capability and to have a 95 per cent availability over 45 days without maintenance. It has an open distributed architecture using COTS hardware and is supported by eight Hewlett-Packard 50 MHz PA-RISC processors in four cabinets (with space in each for a third processor, if required), each performing at 1,000 Mips. The cabinets support command and control functions, search, weapons and datalinks, respectively. The processors feature a real-time exploitation system, using software written in Ada. The system has some 1 million lines of Ada code with a further 400,000 lines written in 'C' for workstation graphics processing. There are 24 (and space for a 25th) CSEE Défense workstations based upon Hewlett-Packard HP9000 series 700 Unix workstations with 99 MHz PA-RISC processing and X-Windows, OSF-MOTIF and STARBASE MMI software. The MMI consists of Barco RGD 651 19 in (48 cm) raster scan screens, alphanumeric displays, a rollerball and softkey panels (one for quick action commands and the other for inputting specific system parameters). Some 12 workstations feature single displays for picture compilation while the remaining 12 are dual-screen units. In addition to a system monitoring workstation there are 10 for the commanding officer, his tactical officer, the anti-air warfare co-ordinator and other members of the combat team. For tactical picture compilation there are workstations for the air and surface/subsurface pictures as well as ones supporting the 2D and 3D radars, the Vampir IRST and electronic warfare suite. The self-defence system has one workstation for electro-optical surveillance and the other to control the system. There is a workstation upon the bridge while the remaining five are used for air traffic control. There will be two Precilec tactical tables. The system interfaces through a real-time, dual-redundant Ethernet ED.103 (10 Mbit/s) network, using a downrated version of the Dassault Electronique real-time deterministic network protocol.

Manufacturer/Contractor
DCN, Paris, France.



SENIT 8 (DCM/CASTEL)

AIDCOMER
AIDCOMER *(Aide de Commandement à la Mer)* uses artificial intelligence to assist in decision making, situation assessment and resource management. It includes a large threat database and interfaces with SENIT 8 within the ship and, externally, with the French Sycom NG national command-and-control system, via the Syracuse 2 satellite link.

Manufacturer/Contractor
Matra CAP Systems, Paris, France.

COMMUNICATIONS AND DATALINKS

Charles De Gaulle carries the normal range of HF, VHF and UHF communications systems for ship-to-ship, ship-to-air and ship-to-shore links, with an estimated total of 60 transceivers, radar detectors, radio-locating devices and jammers. Specific communications facilities include:

Syracuse 2 Satcom
JTIDS (Joint Tactical Information Distribution System) (also known as Link 16)
Fleet Satcom
Inmarsat
VHF Radi Maritime
GPS NAVSTAR
Link 11, Link 14.

WEAPONS CONTROL

VIGY-105

Two VIGY-105 optronic directors. The VIGY 105 three-axis stabilised director provides horizon-to-horizon surveillance against air and surface threats at medium range and designates them for the SADRAL system. The sensors are a high-resolution TV camera, an infra-red sensor and an eye-safe laser rangefinder.

Specifications

Dimensions: 60 × 650 × 150 cm
Weight: 150 kg (approx)
Elevation: −25 to +65°
System harmonisation: <50 µrad

TV camera
Type: Si CCD monochrome CCIR (625 line)
Picture resolution: 768 × 575 pixels
Fields of view: 9 × 12°/3 × 4°

Laser rangefinder
Wavelength: 1.54 µm
Peak power: 20 MW
Output energy: 30 MJ
Pulse repetition rate: 20 Hz
Pulsewidth: 15 ns

Manufacturer/Contractor

SAGEM, France.

IRIS M

IRIS M infra-red sensor.

Specifications

Wavelength: 3-5 µm or 8-12 µm
Detector: 288 × 4 CMT detectors with integral Stirling engine cooling
Fields of view: 9 × 11.5° and 3 × 3.8°

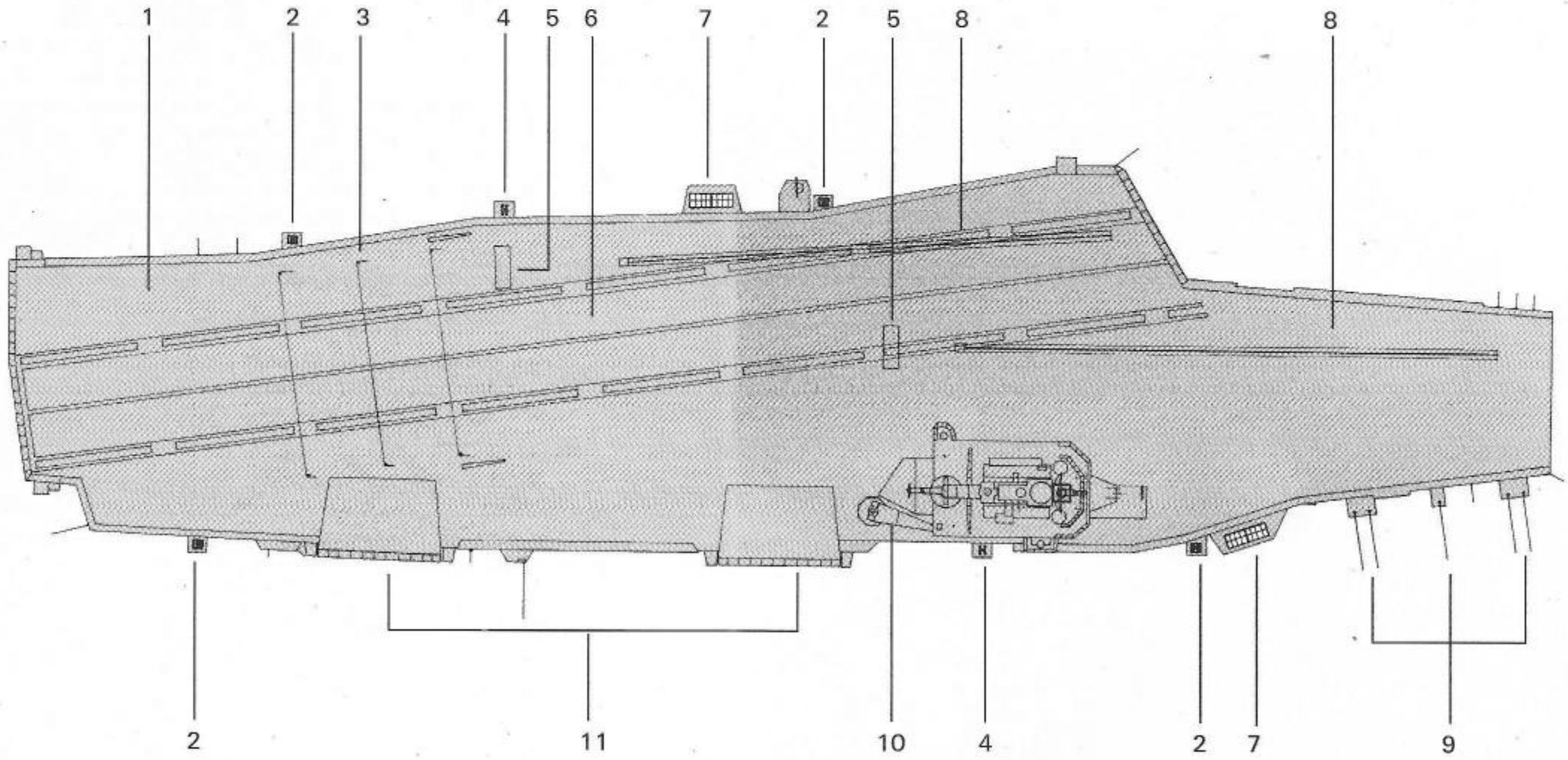
Manufacturer/Contractor

SAGEM, France.

RADARS

Type	DRBJ 11 B	DRBV 26D	DRBV 15C	RM 1229	Arabel
Role	Air search	Air search	Air/surface search; target designation	Surface search/navigation	Frequency-agile 3D, fire-control radar for ASTER missiles
Band	E/F band	D band	E/F band	I band	I/J band
Beam	Electronic phase scanning in both elevation and bearing	2.5 × 8.3 csc^2 to 50°	csc^2 up to 50°	1.2°	70 × 2°
Peak Power	N/A	2 MW	N/A	25 kW	N/A
Gain	N/A	29 dB	30 dB	30 dB	N/A
Pulsewidth	N/A	2.5 µs	N/A	0.05/0.25/0.1 µs	N/A
PRF	N/A	450 pps	N/A	N/A	N/A
Scan rate	15 rpm	7/15 rpm	15/30 rpm	28 rpm	60 rpm
Typical range	approx 200 n miles	150+ n miles on 10 m^2 target	P_d <50% against 2 m^2 target at 60 n miles at heights up 15,240 m (50,000 ft)	48 n miles	about 50 km against missiles with a radar cross-section of 0.5 m^2, and 100 km against larger targets. It can track 50 targets simultaneously and support the engagement of 10
Manufacturer/ Contractor	Thomson-CSF, France	Thomson-CSF, France	Thomson-CSF, France	Racal-Decca, UK	Aerospatiale, France

AVIATION



Charles De Gaulle (Ian Sturton)
1 *Flight deck; 261.5 × 64.4 m,* **2** *SAGAIE decoy launcher,* **3** *Arrester cables,* **4** *SADRAL launcher,* **5** *Jet efflux deflector plate,* **6** *Angled landing deck; 8.3°,* **7** *SAAM vertical launcher for ASTER 15 missiles,* **8** *C 13 catapult,* **9** *Rod antennas (lowered for flying),* **10** *Crane,* **11** *Elevator; 19 × 12.5 m (62.3 × 41 ft), 36 t capacity*

AVIATION FACILITIES

Specifications

Flight deck: 261.5 × 64.4 m (857.7 × 211.3 ft); 12,000 m² (129,172 sq ft)
Height above sea: 17.2 m (56.43 ft)
Angled deck: 8.3°
Hangars: 2 hangars, with total size — 138.5 × 29.4 × 6.1 m (454.4 × 96.5 × 20 ft); total area — 4,600 m² (49,516 sq ft)
Elevators: 2, one serving each hangar, each 19 × 12.5 m (62.3 × 41 ft) and 36 t capacity
Hangar capacity: 23 fixed-wing aircraft; two helicopters
Catapults: 2 USN Type C13; length 75 m (246 ft); 5 *g* acceleration for max 22 t aircraft; each can launch one aircraft every 60 s
Arrester cables: 3, with 96 m (315 ft) travel
Aircraft landing aid: CS Defense Dallas (Deck Approach and Landing Laser System) (to be replaced by MLS system in due course)

Air Wing

See *Aircraft* Section for full details.

Rafale M (Dassault Aviation)

FIXED-WING AIRCRAFT

Dassault Rafale Marine (Rafale M)

40 Dassault Rafale Marine (Rafale M). Single-seat interceptor, multirole fighter and reconnaissance aircraft.

Specifications

Wing span (incl missiles): 10.90 m (35 ft 9 ¼ in)
Length overall: 15.30 m (50 ft 2 ½ in)
Height overall: 5.34 m (17 ft 6 ¼ in)
Weight, empty, equipped: 9,670 kg (21,319 lb)
Weight, max take-off: 21,500 kg (47,399 lb)
Max speed at low level: 750 kts (1,390 km/h)
Max speed at altitude: Mach 2
Radius of action:
low level: 590 n miles (1,093 km)
air-to-air: 1,000 n miles (1,852 km)
Engines: 2 SNECMA M88-3 augmented turbofans, each rated at 48.7 kN (10,950 lb st) dry and 87 kN (19,558 lb st) with afterburning
Accommodation: 1 (pilot)

Manfacturer/Contractor

Dassault Aviation, France.

E-2C Hawkeye

Two E-2C Hawkeye five-seat, carrier-based airborne early warning and control aircraft.

Specifications

Wing span: 24.56 m (80 ft 7 in)
Length overall: 17.60 m (57 ft 8 ½ in)
Weight, empty: 18,363 kg (40,484 lb)
Weight, max take-off: 24,687 kg (54,426 lb)
Max level speed: 338 kts (626 km/h)
Max cruising speed: 325 kts (602 km/h)
Service ceiling: 11,275 m (37,000 ft)
Time on station, 175 n miles (320 km) from base: 4 h 24 min
Endurance with max fuel: 6 h 15 min
Engines: 2–3,803 kW (5,100 ehp) Rolls-Royce/Allison T56-A-427 turboprops
Accommodation: 5 (pilot, co-pilot, plus ATDS Combat Information Center (CIC) staff of CIC officer, air control officer and radar operator)

Manufacturer/Contractor

Northrop-Grumman, USA.

HELICOPTERS

SA 321G Super Frelon

Six Aerospatiale SA 321G Super Frelon shipborne anti-submarine helicopters

Specifications

Main rotor diameter: 18.90 m (62 ft 0 in)
Length overall (rotors turning): 23.03 m (25 ft 7 in)
Length of fuselage: 19.40 m (63 ft 8 in)
Weight, empty, equipped: 6,863 kg (15,130 lb)
Weight, max take-off: 13,000 kg (28,660 lb)

Performance (max take-off weight)
Never exceed speed at sea level: 148 kts (275 km/h)
Cruising speed at sea level: 134 kts (248 km/h)
Max climb at sea level: 300 m (985 ft)/min
Service ceiling: 3,100 m (10,170 ft)
Hovering ceiling in ground effect: 1,950 m (6,400 ft)
Normal range at sea level: 440 n miles (815 km)
Range at sea level with 3,500 kg (7,716 lb) payload: 549 n miles (1,020 km)
Endurance in ASW role: 4 h
Engines: 3 Turbomeca Turmo IIIC$_6$ turboshaft engines rated at 1,170 kW (1,570 shp)
Accommodation: 5 (pilot, co-pilot and 3 flight crew, plus 27 passengers)

Manufacturer/Contractor

Aerospatiale, France.

Hawkeye (H & L van Ginderen Collection)

Super Frelon (Peter Felstead)

PROPULSION

NUCLEAR REACTORS

K15 nuclear reactors

Charles De Gaulle is powered by two K15 nuclear reactors, driving two steam turbines. There are two shafts, each with a five-bladed, fixed-pitch propeller. These reactors use low-enrichment 'caramel' fuel, providing three years between refuellings. The K15 units are identical to those used in the 'Le Triomphant' class SSBNs.

Specifications

Reactors: 2 pressurised-water reactors (PWR)
Type: Nuclear; 2 PWR Type K15
Output power: 2 × 150 MW

Manufacturer/Contractor

DCN Indret, France.

STEAM TURBINES

GEC ALSTHOM steam turbines
Two GEC ALSTHOM steam turbines.

Specifications
Power output: 61 MW (83,000 hp(m))

Manufacturer/Contractor
GEC ALSTHOM, France.

AUXILIARY MACHINERY

Four 4,000 kW turbo-alternators. Four 1,000 W diesel generators. One emergency 800 kW diesel.

K15 nuclear reactor (DCN Indret)

FURTHER INFORMATION

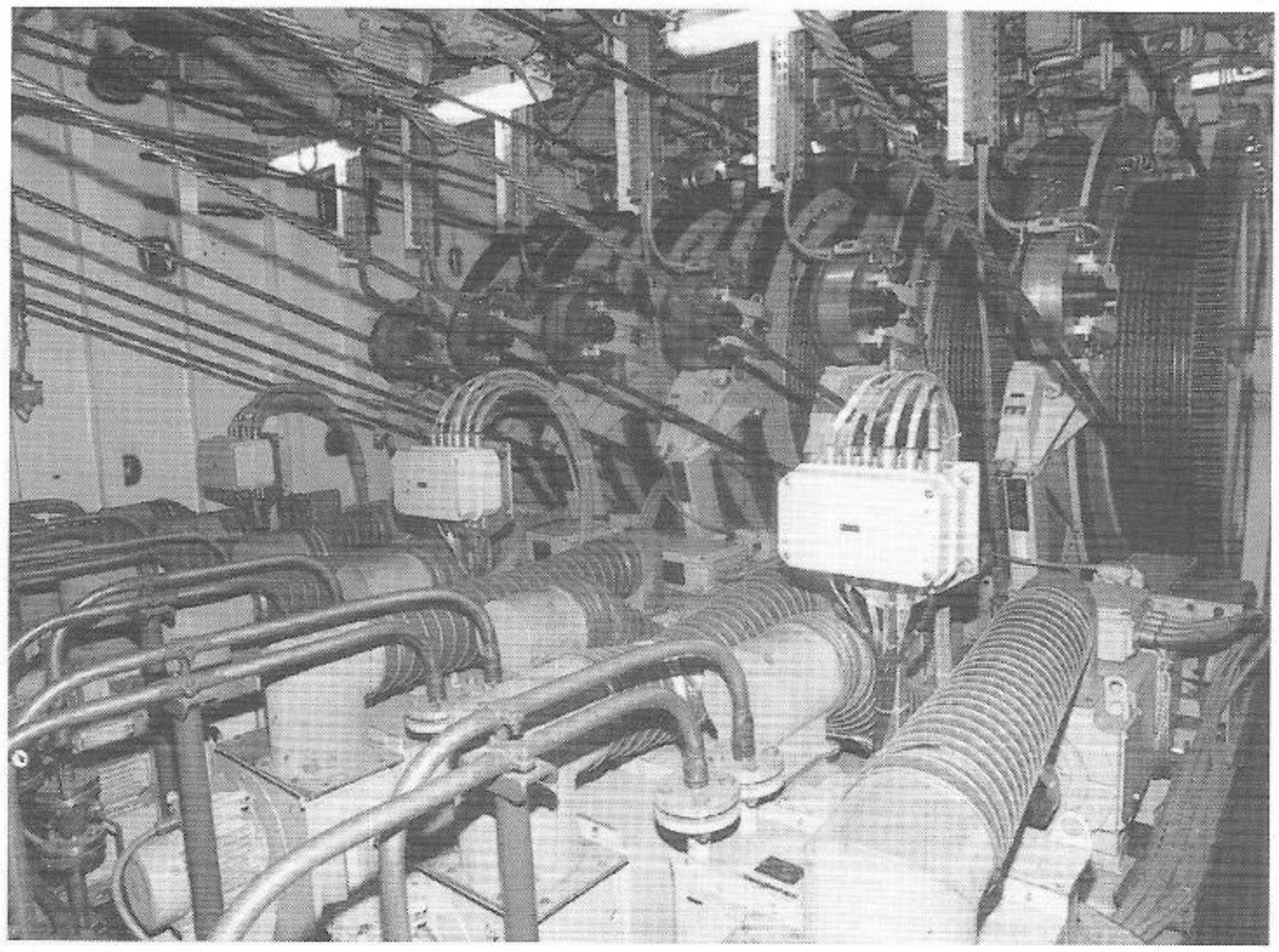
PROGRAMME

On 23 September 1980 the French Defence Council decided to build two nuclear-propelled carriers: the first to replace *Clemenceau* in 1996, the second to replace *Foch* some years later. The nationally agreed missions of these carriers in French strategic planning were to be: operations against land targets; protection of French interests; anti-ship operations; and *pré-stratégique* action.

Funds for trials of the nuclear power plant at Cadarache were provided in the 1982-83 estimates and preliminary work at Brest was funded in the 1984 estimates. The first of class was not actually ordered until 4 February 1986, with first metal being cut on 24 November 1987. The hull was constructed in a dry-dock and was floated out for technical trials on 19 December 1992, returning to the dock on 8 January 1993. A formal unveiling ceremony on 7 May 1994 replaced the traditional launch.

The programme, even for just one carrier, is huge and embraces many segments of French industry. It is estimated that the cost of the carrier itself, plus its ship's systems and communications will be in the

The French aircraft carrier programme has included very considerable expenditure on research and development. One of the items involved was this 1/12 scale model, which was built to test various elements including the SATRAP stabilisation system (DCN)



SATRAP - The set of winches and wires that pull the heavy metal wagons back and forth (DCN)

region of FFr17.2 billion ($3 billion (at 1994 prices)), while the navy's share of the Rafale programme is estimated at a further FFr48.71 billion ($8.6 billion) (also at 1994 values). In addition, US sources indicate that the total cost of the order so far placed by France for two Northrop Grumman E-2C Hawkeye aircraft, plus logistic support, is approximately $562 million. This still leaves another two aircraft to be purchased at a cost of some $59 million each (at 1992 prices).

Various attempts have been made to reduce expenditure: a maximum speed of 27 knots has been accepted, the design of the K15 reactor is the same as that installed in the 'Le Triomphant' class SSBNs and the Rafale M does not have wing-folding. In addition, the building programme has been delayed some 2½ years due to defence budget cuts and, in 1995 it was delayed yet a further six months. The French Parliament has repeatedly expressed concern over the costs of the programme and has made various suggestions to reduce expenditure, including a recent one to cancel the order for the E-2Cs and provide AEW for the carrier task group from the E-3 Sentry force operated by the French Air Force.

The French Navy is very keen to construct a second ship which, without the 'first of class' costs incurred by *Charles De Gaulle*, would cost an estimated FFr11.5 billion. According to French official sources, the normal cycle for *Charles De Gaulle* will be 41 months active duty followed by nine months refit. This means that *De Gaulle*, having entered service in December 1999 will undergo its first refit from June 2003 to February 2004 and the second from July 2007 to March 2008. The first of these will be 'covered' by *Foch*, but this ship is due to be stricken in 2005 and thus *De Gaulle's* second refit will leave the French Navy without an active carrier.

DESIGN

Special attention has been paid to stability and all-weather operation, leading to the unique, five-element SATRAP *(Système Automatique de Tranquilisation de Pilotage)* . The first of these is a passive element – the hull, which has been designed to minimise reaction to waves and weather – but the others are active. Sensors feed ambient condition data to a computer, which controls the active devices, including two rudders, angled outwards to act like aircraft elevons, and four stabilised fins. In addition to these, however, are two wagonettes, each loaded with 250 t of lead ingots, which run on transverse rails mounted across the ship just below the flight deck. The computer harmonises all these devices to reduce hull movement and enables air operations to take place, even in seas up to State 5/6 and also enables the ship to conduct high-speed turns without heeling over. A 19.8 m (65 ft) long, one-twelfth scale model was used for hydrodynamic trials, which included development of the SATRAP system.

As it is expected that *Charles De Gaulle* will spend at least part of its time on disaster relief and humanitarian missions it is fitted with full medical facilities. These include a 600 m² hospital, plus two operating theatres, recovery ward, X-ray theatre, laboratory and dental centre.

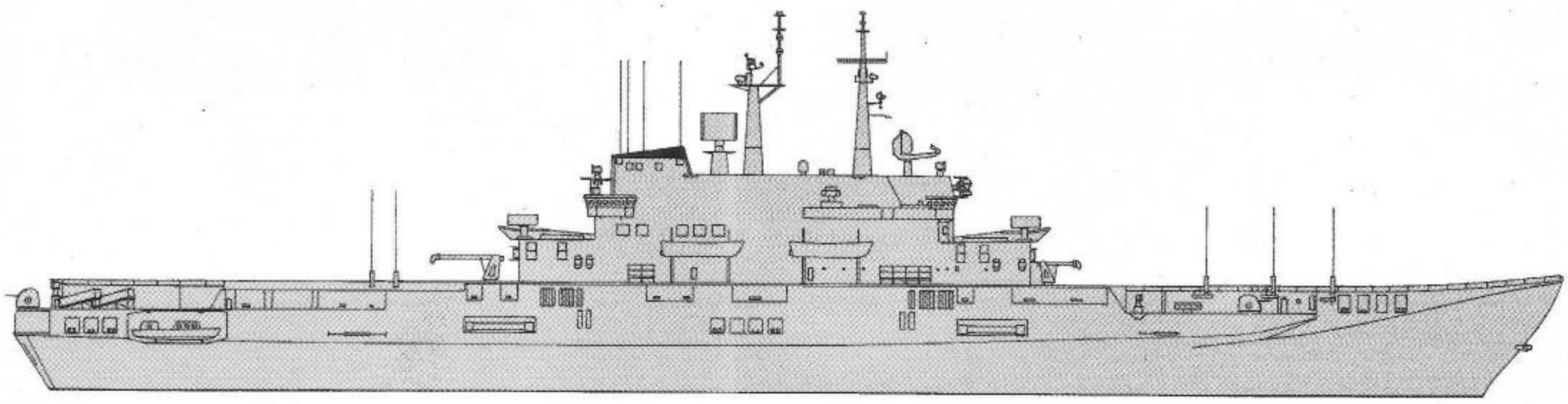
The hangar is divided into two, with each half being served by one lift. The overall length of the flight deck was constrained by the length of the hull, which in turn was held to 238 m (781 ft) by the length of the DCN dry-dock at Brest.

The position of the second catapult on the angled deck prevents simultaneous launch and recovery operations, but French Navy analyses indicate that such operations are seldom undertaken, anyway.

Bridge is noticeably further forward than on any other carrier, partly to maximise parking space, but is also designed to counterbalance the operational requirement to maintain two aircraft permanently at readiness on after deck for launch.

There is no approach radar as such, this function being performed within the SENIT 8 by the fusion of data inputs from the DRBJ-11B and DRBV-15C radars.

GIUSEPPE GARIBALDI



Giuseppe Garibaldi (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: Italy
Type: *Incrociatore Porta-Aeromobili*; aircraft carring cruiser (CVS)

Class: GIUSEPPE GARIBALDI

Active: 1
Building: 0
Proposed: 1 (see 'Further Information')

Displacement:
standard: 10,100 t
full load: 13,850 t
Length: 180 m (591 ft)
Beam: 33.4 m (110.2 ft)
Draught: 6.7 m (22 ft)

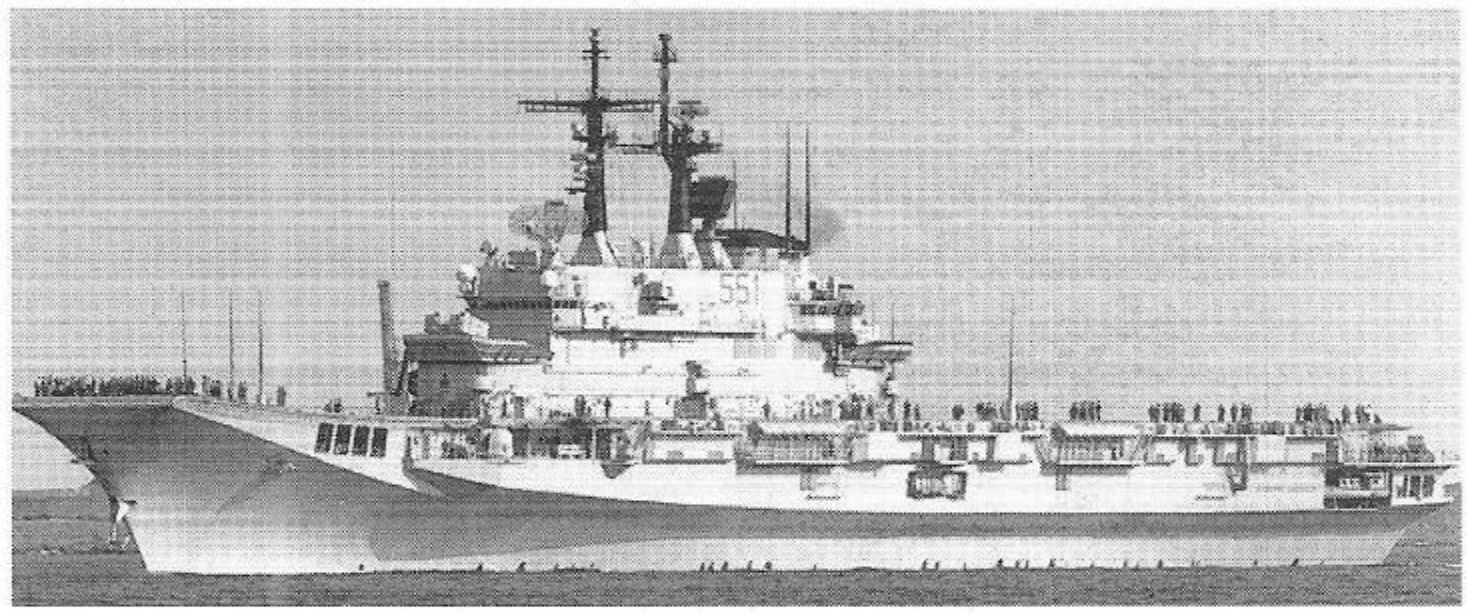
Speed: 30 kts
Range: 7,000 n miles at 20 kts

Complement:
ship's company: 550
air group: 230
Flag and staff: 45
Total: 825

SHIP

GIUSEPPE GARIBALDI (C 551)

Builder	Italcantieri, Monfalcone, Italy
Laid down	26 Mar 1981
Launched	4 Jun 1983
Commissioned	9 Aug 1987



Giuseppe Garibaldi *has proved a major success and the Italian Navy is now seeking funds to construct a second and larger carrier* (Jane's/H M Steele)

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

OTOBREDA Teseo Mk 2

Giuseppe Garibaldi mounts two, four-cell Otomat Mk 2 Teseo launchers. Targets are acquired by radar, either from the ship itself, other ships in company or helicopters. The ship does not have to be facing the target as the missile can turn through an angle of ±200° and once on course it climbs to 150 m (492 ft), reaching cruising speed some 4 km (2.15 n miles) from the launch point, where the boosters are jettisoned. It then descends to cruising height and continues towards the target with mid-course guidance correction from the helicopter until the azimuth-only radar seeker is activated at a predetermined point and scans a 40° sector. Once the target is acquired (at a range of about 12 km (6.5 n miles)) the missile descends to sea-skimming height for the final run-in. An Agusta-Bell AB 212 ASW helicopter is an essential part of the system, equipped with SMA MM/APS-705 I-band radar and the PRT-405 tracking and datalink system. Indeed, it is reported that the helicopter acts as a waypoint and only when the missile passes under the helicopter does the latter transmit target location data. The Otomat system is capable of engaging two separate targets simultaneously in sea states up to Force 7.

Specifications
Length: 4.46 m (14.6 ft)
Diameter: 46 cm (1.5 ft)
Wing span: 1.36 m (4.5 ft)

An EH-101 prototype (PP-06, the Italian preproduction aircraft) flies past the stern of Giuseppe Garibaldi; *the carrier will be the main naval platform for this aircraft, where it will replace the Sea Kings. Two OTOBREDA Teseo launchers are tucked neatly beside the after end of the flight deck, with one of three twin 40 mm turrets just visible on the transom* (Westland Helicopters)

Weight: 762 kg (1,680.2 lb) (without boosters); 770 kg (1,697.8 lb) (with boosters)
Engine: Turbomeca TR 281 Arbizon III turbojet; 400 kg static thrust
Boosters: 2—75 kg SNPE solid propellant boosters; 3,500 kg static thrust (each); burn time, 4 s
Range: 86 n miles (160 km)
Speed: Mach 0.9
Guidance: Inertial and active radar homing
Cruise height: 15-20 m (49-65.6 ft)
Warhead: Semi-armour-piercing 210 kg; 65 kg (463 lb; 143.3 lb) high explosive
Penetration: 8 cm nickel-chromium armour
Fuzes: Impact, proximity

Manufacturer/Contractor
OTOBREDA (formerly OTO Melara), Rome, Italy.

SURFACE-TO-AIR MISSILES (SAM)

Alenia Elsag Albatros
Two Alenia Elsag Albatros four-cell launchers, with a total of 48 Aspide missiles. This modular system interfaces with and complements the gun system to produce an overlapping, layered, air defence against both aircraft and anti-ship missiles. The seeker has a home-on-jam capability and the missile delivers a Difesa e Spazio 33 kg (72.8 lb) preformed fragmentation warhead. Illumination energy is routed to the tracker antenna through an I/J-band waveguide. The system has a very short reaction time, the radar becoming operational within 2 seconds. Albatros is used with one or two directors, the launcher being automatically slaved to one director during the operation. The launcher unit has eight cells, four on each side of the mounting, each with a frangible front and rear cover and a loading guide to which the launching rail of the missile is electrically and mechanically connected.

Specifications
Length: 3.7 m (12.1 ft)
Diameter: 20.3 cm (8 in)
Wing span: 80 cm (31.5 in)
Weight: 220 kg (485 lb)
Speed: Mach 2.5
Max range: 15 km (horizontal)
Altitude: 15-5,000 m (50-16,405 ft)
Warhead: 33 kg (72.8 lb)
Guidance: Semi-active radar
System reaction time: 8 s
Max firing rate: 1 missile every 2.5 s

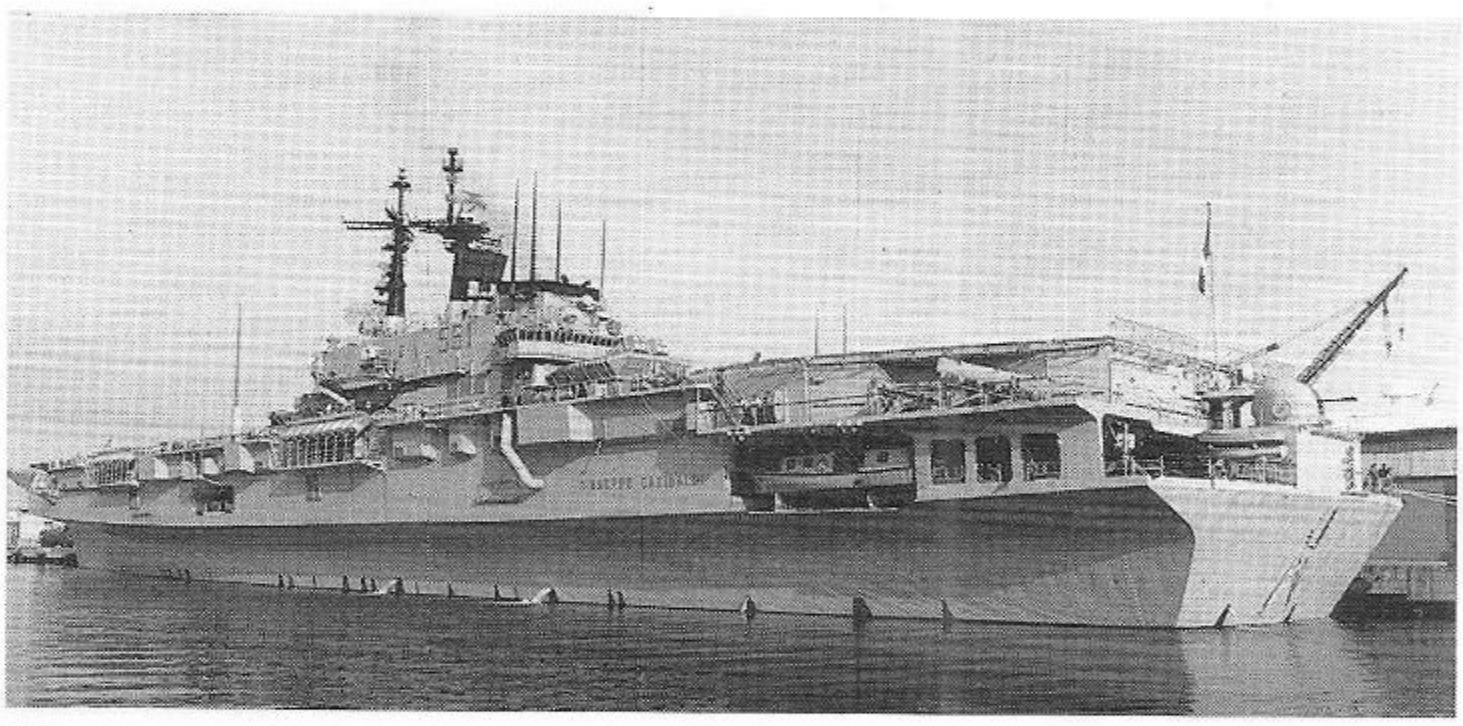
Manufacturer/Contractor
Alenia Elsag Sistemi Navali, Rome, Italy.

TORPEDOES AND LAUNCHERS

Whitehead B515/ILAS-3 triple torpedo launchers
Giuseppe Garibaldi carriers two triple-tube B515/ILAS-3 installations mounted port and starboard on the half-deck below the forward flight deck. Each of these installations consists of three 324 mm (12.75 in) diameter torpedo tubes mounted with two tubes below and one above. The tubes are manually loaded and the unit is manually trained between 35 and 145°, but launching is by remote control from the combat information centre.

Specifications
Length: 3.4 m (11.15 ft)
Height: 1.2 m (3.94 ft)
Width: 1.285 m (4.22 ft)
Weight: 1,050 kg (2,314 lb) (unloaded)
Power requirement: 115 V, 60 Hz and 115 V, 400 Hz

Manufacturer/Contractor
Whitehead SpA, Italy.



This port quarter view shows the extensive flying control at the rear of the superstructure with the after octuple Albatros launcher for Aspide SAM below. Also evident are the port Teseo SSM launchers and the Dardo two 40 mm CIWS (Jane's/H M Steele)

Eurotorp Impact 324 mm torpedo
The Eurotorp Impact 324 mm (12.75 in) ASW torpedo entered service in 1995, replacing the Mk 46 in Italian Navy service. A combined Franco-Italian project, the new torpedo uses the seeker developed for the French Murène, the warhead and guidance system developed for the Italian A 290, Murène software and battery, and the A290 afterbody. The Thomson-Sintra seeker, with its Mangouste processor, uses very high-capacity data processing for sophisticated signal processing and the weapon is reportedly capable of tracking up to 12 targets simultaneously. The 30-transducer planar array, two side arrays and depth finder all operate on separate frequencies to overcome reverberation and false echo problems. The Whitehead shaped charge warhead weighs some 50 kg (110.2 lb).

Specifications
Diameter: 324 mm (12.75 in)
Speed: 45 kts
Propulsion: STN stepless, variable speed, electric motor driving a pump-jet propulsor
Battery: Silver oxide-aluminium battery with a potassium hydroxide electrolyte

Manufacturer/Contractor
Eurotorp, Sophia Antipolis Cedex, France.

GUNS

OTOBREDA Compact 40 mm/70
The three OTOBREDA Compact twin 40 mm (1.6 in) mountings are designed for use against high-performance combat aircraft, anti-ship missiles and surface targets and consist of two 40 mm (1.6 in) guns 300 mm (11.8 in) apart, a feeding system with magazine, a local control panel, a power supply rack, a converter and an air-water panel. The guns are an integral part of the carrier's CIWS and are integrated with the Albatros missile system by the Dardo fire-control system.

Specifications
Calibre: 40 mm
Barrel length: 70 calibres (2.8 m)
Muzzle velocity: 1,000 m/s (34,280 ft/s)
Max range: 6.75 n miles (12.5 km)
Effective range:
  surface targets: 3.25 n miles (6 km)
  air targets: 4,000 m (13,124 ft)
Rate of fire: 600 rds/min (300 rds/min/barrel)
Ammunition: 2.4 kg (HCHE, PFHE), 2.5 kg (HE-T)
Weight of shell: 0.96 kg (2.1 lb)
Traverse: 360° at 90°/s
Elevation: −3 to +85° at 60°/s
Weight (unloaded): 5.6/5.4 t
Power requirements: 440 V, 60 Hz, 3-phase, peak power 13 kW

Manufacturer/Contractor
OTOBREDA, Rome, Italy.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES ELECTRONIC COUNTERMEASURES (ESM/ECM)

Nettuno radar detection and countermeasures system
The Nettuno integrated radar ESM/ECM system is claimed to have a 100 per cent intercept of emitters, using passive surveillance based on environmental synthesis. A very high level of automation ensures immediate and automatic identification based on a powerful threat library, and accurate tracking of emitters. Computer-controlled processing employs structured modular software using a high-level language. There is full, interactive integration with the command and control systems, and also with the flare/chaff launcher systems. Roll-stabilised, multibeam DF antennas provide high bearing accuracy and feature high sensitivity, wide dynamic range logarithmic amplifiers and completely digital processing. The ECM section provides self-protection by environment adaptive instant-by-instant automatic jamming, even against simultaneous multiple threats. However, command and control, or the operator, can override the system if necessary. The high-power jammer antennas are roll-stabilised and consist of linear arrays that electronically steer a precise and narrow high-gain beam. Jamming implementation follows automatic instructions provided by the ESM section and by the power management computer. High ERP is achieved by using a transmitter design employing paralleled matched high-power Elettronica-designed TWTs.

Manufacturer/Contractor
Elettronica SpA, Rome, Italy.

AN/SLQ-25 Nixie noisemaker
The AN/SLQ-25 Nixie is a solid-state, modular design electro-acoustic countermeasures decoy system used to protect the carrier from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 487.5 m (1,599.5 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408.24 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for

corrosion resistance, are 94.6 cm (3.1 ft) long, 15.24 cm in diameter and weigh 18.14 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed bodyat a time is deployed.

Manufacturer/Contractor
Aerojet ElectroSystems, Sacramento, USA.

OTOBREDA SCLAR multipurpose rocket launchers
Two, 20-tube Breda SCLAR, multipurpose, rocket launchers for SNIA 105 mm countermeasure rockets and an Alenia (formerly Elsag) UCLAR control unit. The 20-tube launchers are 1.66 m (5.4 ft) high, 1.5 m (4.9 ft) long and 1.3 m (4.2 ft) wide, and are mounted on each side of the ship and they can be trained and elevated by remote control. The control unit is linked to the ship's radar and a control panel in the ECM compartment to provide the necessary operating signals, with the data needed to stabilise the two launchers against pitch and roll being provided by the ship's gyrocompass. The SCLAR 105 mm (4.1 in) rocket launcher system provides defence against radar and IR homing missiles, confuses enemy radars, and provides illumination for visual fire control at night. Provision is made to load different types of rockets in various arrangements (long-range chaff, medium-range chaff, illuminating) to permit mixed salvos. Automatic selection of the rockets to be fired is possible from the remote fire control unit and the time fuzes and launch sequence may be similarly controlled.

The rockets all have double-base propellant motors with folding fins and electronic fuzes while their speed to burnout is 260-645 m/s (8.53-2,116.2 ft/s).

Specifications
Launcher weight: 1.15 t (empty); 1.75 t (with 20 rockets)
Trunnion height: 1.17 m (3.8 ft)
Traverse: 300° at 60°/s
Elevation: −5 to +60° at 30°/s
Rate of fire: 1 rd/s

Chaff distraction rocket
Type: SNIA 105 LR-C
Length: 1.85 m (73 in)
Diameter: 105 mm
Max range: 12 km (13,120 yd)
Weight: 27 kg (59.5 lb)
Payload: 10.2 kg (22.5 lb)

Chaff seduction rocket
Type: SNIA 105 MR-C
Length: 1.83 m (72 in)
Diameter: 105 mm
Max range: 4.7 km (5,140 yd)
Weight: 29 kg (63.9 lb) (SNIA 105 MR)
Payload: 17.4 kg (38.4 lb)

Infra-red seduction
Type: SNIA 105 MR-IR

Illumination
Type: SNIA 105 LR-I
Payload: 10.2 kg (22.5 lb)
Range: 12 km (13,120 yd)

Main power supply: 440 V, three-phase, 60 Hz
Main power consumption: 3 kW

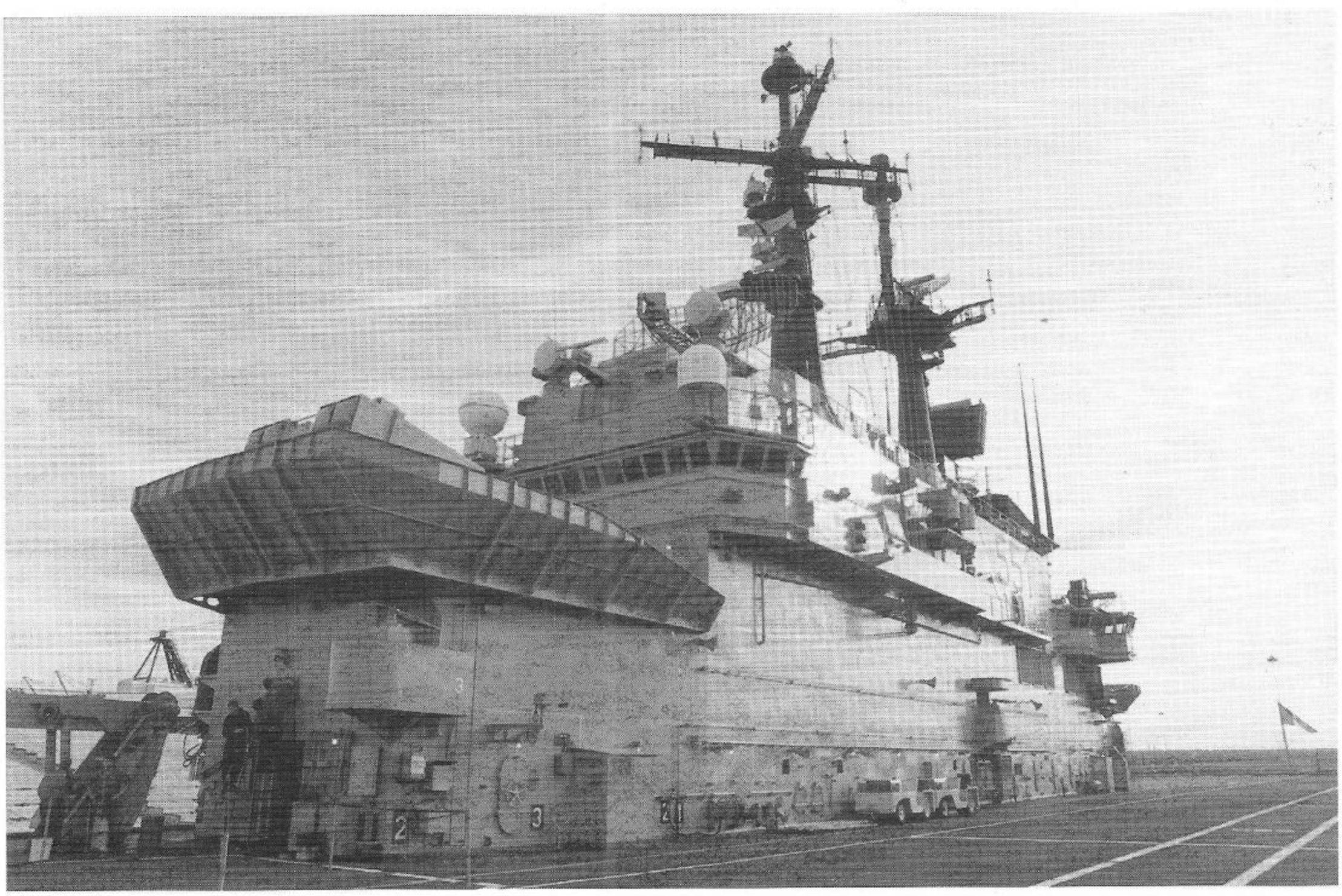
Manufacturers/Contractors
Breda Meccanica Bresciana SpA, Brescia, Italy (launcher).
BPD SpA, Rome, Italy (rockets).

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

SADOC 3/IPN 20
SADOC 3/IPN 20 (SADOC = *Systema Direzione della Operazioni di Combattimento*) is designed to produce an up-to-date picture of the tactical situation within the vicinity of both the ship and task group and uses a main-frame architecture to acquire, process and present data acquired by sensors. It is also used for threat evaluation, weapons control, ECM management, aircraft control, conducting ASW operations, and datalink databank management. Data are received from onboard sensors and also from offboard sensors via Link 11, 14 or 16. In addition, track information is exchanged with NADGE (NATO Air Defence Ground Environment) sector operational centres via a Link 11/Link 1 Ship-Shore-Ship Buffer, which also enables the carrier to direct shore-based aircraft allocated to its control. The system has three Alenia 32-bit CP-7010/7020 Central Processing Units (CPU), each with 128 k memories, of which one usually acts as the back-up in the event of system failure. Within the consoles are Alenia 16-bit NDC-160, with 64 k memories. Both possess mass memory modules for handling programmes and large amounts of data and an interface with a 10 Mbit/s serial databus. The basic software of the latter is under the control of two TAVITAC operating systems; the disk operating system and a time-sharing executive. The CPUs are supported by a Tape Cassette Unit (TCU) with three transporters to provide initial programme loading by means of cartridge cassette magnetic tape. They are also used for data recording and retrieval. Input/output (I/O) expander and converter units interface with external systems and an I/O terminal to monitor the system and to provide offline hard copy records. The system is also associated with radar tracking units (RTU) for radar video extraction and automatic tracking and radar central units (RCU) for distributing radar data.

Manufacturer/Contractor
Alenia Elsag Sistemi Navali, Rome, Italy.



The superstructure, showing the forward octuple Albatros launcher and a formidable array of antennas. Immediately above the bridge are two satellite antennas, with two SPG 75 fire-control radars above them and in between the SPN 749(V)2 navigation radar. On the bridge roof is the large open mesh antenna for the SPS 768 air search radar. Immediately aft of the mainmast is the large rectangular array for the Hughes SPS 52C (Jane's/H M Steele)

COMMUNICATIONS AND DATALINKS

The ship carries the usual communications equipment associated with its role as a flagship and as an aircraft carrier, including the normal range of HF, VHF and UHF radios. Particular communications facilities include:

Link 1
Link 11
Link 14
Link 16
MARISAT Satcom
Mk XII IFF
SRN-15A TACAN.

RADARS

Type	SPS 52C	SPS 768 (RAN 3L)	SPS 774 (RAN 10S)	SPS 702	SPN 749(V)2	SPG 75 (RTN 30X) (Three)	SPG 74 (RTN 20X)	SPN 728(V)1
Maker	Hughes	Selenia	Selenia	SMA	SMA	Selenia	Selenia	Selenia
Role	3D long-range air search	2D air search	Air/surface search	Surface search/ target indication	Navigation	Fire control (Albatros)	Fire control (Dardo)	Carrier-controlled approach (CCA)
Band	E/F	D	E/F	I	I	I/J	I/J	I
Beam	1.1 × 2.25°	2.15 × 9° csc²	1.5 × 17°					
Peak power	1,000 kW	135 kW	140 kW				200 kW	
Gain	39.5 dB	30 dB	28 dB					
Pulsewidth	2.5/4.6/10 µs	1.6 µs	0.4 µs				1.5 µs	
PRF	1,850/925 pps		900 pps				450-550 pps	
Scan rate	15/6 rpm	6 rpm	15/30 rpm					
Typical range	440 km (240 n miles)	220 km (120 n miles)	155 km (85 n miles)			15 km (8 n miles)	13 km (7 n miles)	

SONAR

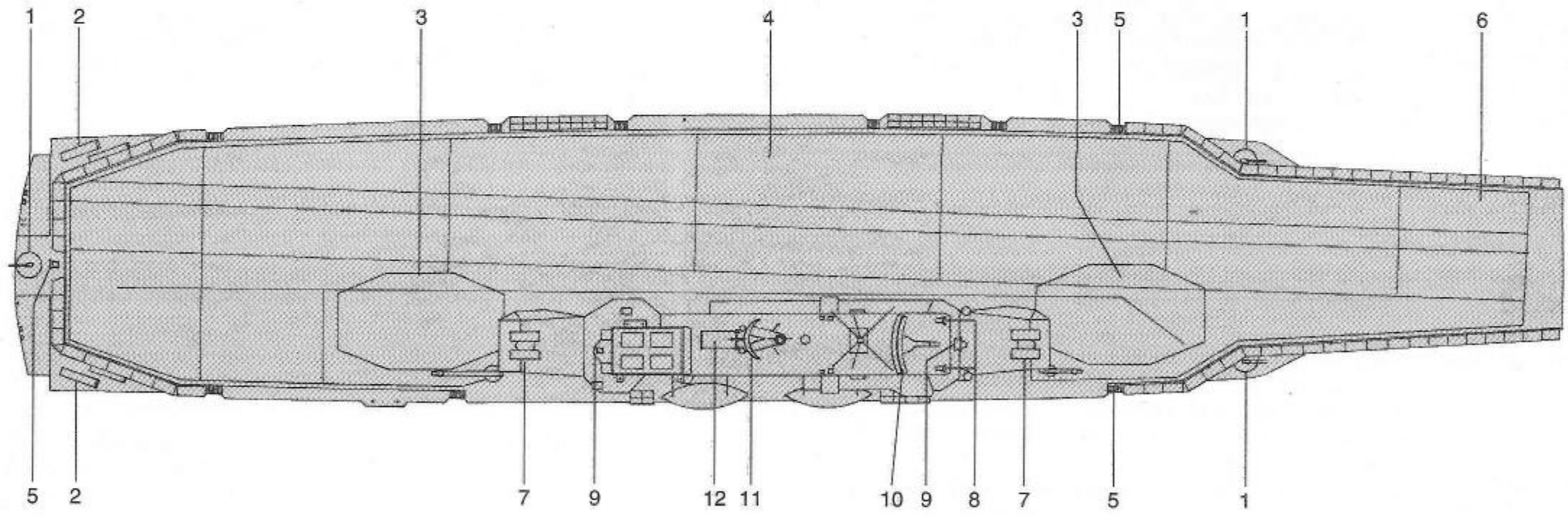
Raytheon DE 1160

Giuseppe Garibaldi is fitted with a bow-mounted Raytheon DE 1160LF (low-frequency) sonar. This is an export version of the US Navy's AN/SQS-56, but is equipped with a larger, low-frequency transducer array to give it convergence zone capability.

Specifications
Modes: Active and passive (both fully digital)
Frequencies: 5.6, 7.5, 8/4 kHz
Power output: 36 kW

Manufacturer/Contractor
Raytheon Company, Portsmouth, Rhode Island, USA.

AVIATION



Giuseppe Garibaldi (Ian Sturton)
1 *OTOBREDA 40 mm/70 twin* **2** *OTOBREDA Teseo Mk 2 SSM launcher* **3** *Elevator* **4** *Flight deck* **5** *Selenia (now Alenia) SPG 74 (RTN 20X) fire-control radar (for Dardo)* **6** *Ski ramp* **7** *Alenia Elsag Albatros octuple launchers for Aspide SAM* **8** *Selenia SPG-75 (RTN 30X) fire control (for Albatros)* **9** *SATCOM antennas* **10** *Selenia SPS 768 (RAN3L) air search radar* **11** *Selenia SPS 774 (RAN 10S) air/surface search radar* **12** *Hughes SPS 52C long-range air search radar*

AVIATION FACILITIES

Specifications
Flight deck: 173.8 × 30.4 m (570.2 × 99.7 ft)
Ski ramp: 6.5°
Elevators: 2—18 × 10 m (59 × 32.8 ft), 15 t capacity elevators, offset to starboard, forward and aft of the superstructure
Hangar: 110 × 15 × 6 m (361 × 50 × 20 ft)
Landing aid: Marconi Deck Approach Projector Sight (DAPS)

Air Wing
The composition of the air wing is flexible. If the carrier is fully devoted to one type of aircraft it can operate either 16 AV-8B Harrier IIs or 18 Agusta-Sikorsky AS-61 (licence-built SH-3D) Sea King helicopters, 12 of which would be parked in the hangar and 6 on deck. In most situations, however, a mixture would be carried and in mid-1994, for example, the carrier operated in the assault role with 7 AS-61s and 4 AB 212 naval helicopters, together with 6 AB 205, 3 A 129 and 2 CH-47 from the army.

Embarked aircraft are operated by the navy with the air force providing evaluation and maintenance, and any additional pilots that may be required. The navy acquired two trainer TAV-8B aircraft in early 1991.

McDonnell Douglas/BAe AV-8B Harrier II Plus

Specifications
Wing span: 9.25 m (30.33 ft)
Length: 14.12 m (46.33 ft)

Height: 3.55 m (11.89 ft)
Operating weight, empty: 6,336 kg (13,968 lb)
Max take-off weight:
short take-off (STO): 14,061 kg (31,000 lb)
vertical take-off (VTO): 8,596 kg (18,950 lb)
Max fuel:
internal: 3,519 kg (7,759 lb)
external: 3,661 kg (8,070 lb)
Max weapon load: 4,899 kg (10,800 lb) (with -406A engine)
Max level speed, low altitude: 575 kts (1,065 km/h)
Attack radius: 250 n miles (463 km; 288 miles)
Engine: 1 Rolls-Royce Pegasus F402-RR-408 turbofan (105.87 kN; 23,800 lb st)
Accommodation: 1 (pilot only, on Martin-Baker Mk 10H zero/zero rocket ejection seat)
Weapons: 30 mm guns, bombs, rockets and flares
Sensors: Hughes APG-65 multirole radar.

Two of the types of aircraft that will be embarked in Giuseppe Garibaldi: *McDonnell-Douglas/BAe TAV-8B Harrier II Plus and an Agusta-Sikorsky SH-3D Sea King. The carrier can also embark various combinations of helicopters.* (Naval HQ, Rome)

HELICOPTERS

Agusta-Sikorsky AS-61 (SH-3D)

Specifications

Main rotor diameter: 18.90 m (62.0 ft)
Length overall (both rotors turning): 21.91 m (71.89 ft)
Fuselage length: 16.69 m (54.75 ft)
Height to rotor head: 4.74 m (15.5 ft)
Rotor disc area: 280.5 m² (3,019 sq ft)
Max take-off weight: 9,525 kg (21,000 lb)
Internal cargo capacity: 2,720 kg (6,000 lb)
Max speed (never exceed): 144 kts (267 km/h)
Typical cruising speed: 120 kts (222 km/h)
Service ceiling: 3,720 m (12,200 ft)
Range with max standard fuel: 630 n miles (1,166 km)
Engines: 2–1,118 kW (1,500 shp) General Electric T58-GE-100 turboshafts
Role equipment: Underwing pylons (6), torpedo bay, sonobuoy ports (32), depth-charge racks (2), search radar, FLIR, MAD
Accommodation: 4 (pilot, co-pilot, two sonar operators)
Sensors: Low-frequency 360° AQS-18/AQS-13F sonar; Doppler radar; SMA/APS-707 radar (chin radome)
Weapons: Homing torpedoes (A 224AS, Mk 44 or Mk 46) (2 or 4); or depth charges (4), or Exocet AM39 anti-ship missiles (2)

PROPULSION

Specifications

System: Combined Gas-And-Gas (COGAG)
Main machinery: 4 Fiat/GE LM 2500 gas turbines
Power output: 60 MW (81,000 hp) sustained
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The Italian Navy has long appreciated the value of seaborne aviation and sought to construct two aircraft carriers during World War Two, although neither was ever completed. During the Cold War, the navy built some excellent cruisers and destroyers fitted with hangars and large flight decks, which could operate quite large numbers of helicopters; the ASW cruiser *Vittorio Veneto,* for example, operated an air wing of six Agusta-Bell AB.212 helicopters. It was not until the late 1970s that the navy finally obtained political agreement to construct a ship with a full-length flight deck, although, as with the British 'through-deck cruisers', a political fiction was maintained that this was a cruiser with enhanced air capabilities rather than an aircraft carrier, as such. The contract was awarded on 21 November 1977, design work was completed in February 1980, engineering work began in March 1980 and the keel was laid on 26 March 1981. Thereafter progress was rapid, with launch taking place on 4 June 1983, sea trials started on 3 December 1984 and this totally new design entered service on 30 September 1985.

There was still another problem, however, since a law dating back to 1923 laid down that the air force was responsible for the provision of fixed-wing support of the navy, and the air force of the 1980s refused flatly to either operate V/STOL aircraft on the navy's behalf or to allow the navy to provide its own pilots. This impasse persisted well beyond the entry into service of the *Giuseppe Garibaldi* — and despite the very obvious ski ramp already installed — until eventually an amendment to the law was passed on 29 January 1989 and the navy was at long last allowed to place an order for AV-8B Harrier IIs, with the first operational Harriers embarking for permanent duty in December 1994.

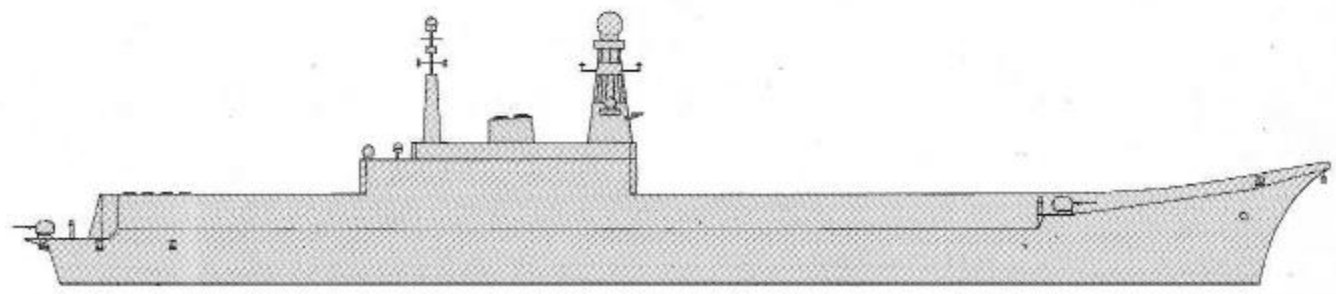
DESIGN

The ship is an exceptionally neat design, which manages to fit a great deal of capability into a relatively small hull. There are six decks, of which the hangar deck is the strength deck, and 13 vertical watertight bulkheads. The flight deck, which is slightly narrower than that of the British 'Invincible' class, culminates in a full-width ski ramp, although, at 6.5°, it is set at half the angle of its British and Spanish contemporaries.

The ship carries a considerable amount of weaponry, including four SSM launchers, two SAM launchers, three twin 40 mm gun mounts and six torpedo tubes. Two 'MEN' class fast personnel launches (capacity 250) can be embarked for amphibious operations or disaster relief.

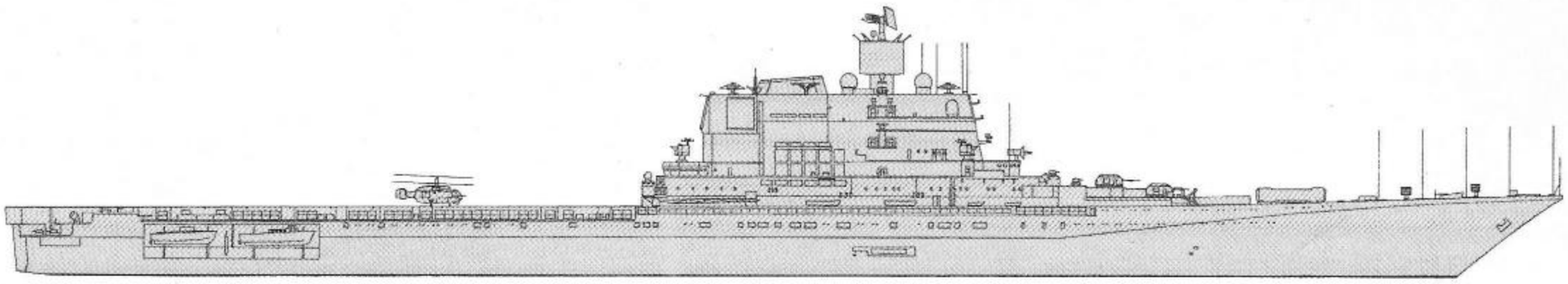
THE FUTURE

As with other navies which operate just one ship in an important category, the greatest problem arises when the ship has to go into dock for a major refit and having now been in service for eleven years, the *Giuseppe Garibaldi* must be due for a major refit shortly. There was talk in the late 1980s of a sister ship, which might have been named either Giuseppe Mazzini or Conte di Cavour, to replace *Vittorio Veneto* in the mid-1990s. This project was, however, suspended in 1990 but has been be revived in a different design. The second carrier will be a larger ship, displacing 20,100 tonnes. Currently designated *Nuova Unita Maggiore* (NUM) the new carrier's design resembles that of the Spanish *Principe de Asturias*.



Project NUM (Ian Sturton)

ADMIRAL GORSHKOV



Admiral Gorshkov (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: Russia
Type: Project 1143.4 *Taktycheskiy Avionosnyy Kreyser* (TAKR); tactical aviation cruiser; aircraft carrier guided missile (CVG)

Class: MODIFIED KIEV

Active: 1

Displacement:
standard: 32,000 t
full load: 40,400 t
Length: oa 274 m (899 ft); wl 249.5 m (818.6 ft)
Beam: oa 51 m (167.3 ft); wl 32.7 m (107.3 ft)

Draught: screws 10 m (32.8 ft)

Speed: 32 kts
Range: 13,500 n miles at 18 kts; 4,000 n miles at 31 kts

Complement: 1,200 plus aircrew

SHIPS

ADMIRAL FLOTA SOVETSKOGO SOJUZA GORSHKOV

Builder	Nikolayev South
Laid down	Dec 1978
Launched	17 Apr 1982
Commissioned	Jan 1987

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

P-35 (NATO = SS-N-12 Sandbox)

There are 12 launch tubes on the foredeck for the P-35 missiles, grouped in six pairs: a forward row of four pairs, with a row of two pairs behind. There is one reload per tube, the two-level magazine being located beneath the missile battery, with the missiles being transferred by railborne trolleys and lifts to the weather deck, where they are then delivered along further rail tracks. Prior to launch, hinged efflux deflector plates are raised and the tubes are raised to an angle of 30° before the tube end caps are opened.

The missile is associated with the 'Front Door C,' F-band missile guidance radar, housed in a casing with the antenna on the inside cover, which hinges back to expose the antenna, when required. Target data are acquired through the ship's search radar or satellites using the Punch Bowl satellite data receiving system. Missiles are launched towards the target and guidance updates are provided through the shipborne missile guidance radar or, in an Over-The-Horizon (OTH) engagement, from aircraft such as Tu-95 (Bear D), Ka-25 (Hormone B) or the Ka-27 (Helix B) with Big Bulge I/J-band radar. The missile is reported to be capable of adopting either high- or low-altitude cruise profiles.

Specifications
Length: 11.7 m (38.4 ft)
Diameter: 88 cm (34.65 in)
Wing span: 2.1 m (6.89 ft) (approx)
Weight: 4,600 kg (10,141 lb)
Speed: Mach 1.7
Range: 296 n miles (550 km) with OTH targeting

Admiral Gorshkov *(when named* Baku*) showing the heavy armament fitted to Soviet air-capable cruisers to compensate for their limited air groups. The forward rectangular phased array of the Sky Watch 3D air search radar is above the bridge, with the huge cylindrical Cake Stand TACAN at the masthead* (Jane's)

Guidance: Inertial (with command updates) and active radar
Warhead: HE (1,000kg (2,205 lb)); or nuclear (350 kT)

Manufacturer/Contractor
NPO Mashinostroyenia, Russia.

SURFACE-TO-AIR MISSILES (SAM)

Kynshal (NATO = SA-N-9 Gauntlet)
There are four clusters of six vertical launchers for the Kynshal point air defence system, each with eight missiles, for a whole-ship total of 192 missiles. This system is designed for all-weather defence against aircraft, missiles and small craft and consists of the 9M330 missile, the handling-launcher system and the computer-based radar fire-control system. The missiles are launched vertically from 8-missile, cylindrical, launcher-containers with a gas ejection system, which carries them to a height of 18 to 20 m (59 to 65.6 ft) at which point the booster-sustainer comes into operation. The computer-controlled radar fire-control system is highly automated apparently using one computer for the 'Cross Sword' radar system and two to control the remainder of the Kynshal system and to interface with sensors.

Specifications
Length: 3.5 m (11.48 ft)
Diameter: 23.5 cm (9.25 in)
Wing span: 75 cm (29.5 in)
Weight: 165 kg (364 lb)
Speed: Mach 2.5
Range: 0.5-6.5 n miles (1.5-12 km)
Altitude: 6,000 m (19,685 ft)
Guidance: Command guidance, active radar homing
Warhead: 15 kg (33 lb) HE fragmentation warhead
Fuzes: RF, proximity, impact
Crew: 13 (complete system)
Targets: A max of eight missiles can be controlled to engage a max of four Mach 2 targets simultaneously
Availability:
from cold-start: 3 min
from alert: 15 s
Response time: 8-24 s (depending on the search radar mode of operation)

Manufacturers/Contractors
Altair Research and Development Corporation, Russia (system).
Fakel, Kaliningrad, Russia (missile).

GUNS

Two 100 mm (3.9 in) L/70 guns are mounted in single turrets on the foredeck. This weapon fires at 80 rds/min and is water-cooled, the hose running along the left of the barrel to the water reservoir, which is on the left of the mounting. The weapon fires fixed rounds, probably using a drum feed, with a total of about 80 rounds on the mounting. The turret is unmanned. There is an electro-optic sensor at the front to the left of the elevating mass and the L/70 is associated with the Kite Screech G/I-band fire-control radar with the NATO codename 'Kite Screech'. This is a G/I-band radar, with one such radar controlling up to two guns and it is likely that the radar compartment for this sensor also acts as the fire-control centre.

Specifications
Calibre: 100 mm (3.9 in)
Barrel length: 70 calibres
Muzzle velocity: 850 m/s
Traverse: 360°
Elevation: −10 to +85°
Weight of projectile: 6.8 kg
Rate of fire: 80 rds/min
Range:
surface/surface: 8 n miles (15 km)
air defence: 8,000 m

AK-630 30 mm/65 Gatling CIWS
Eight 30 mm 65-calibre AK-630 Gatling close in weapon systems. These have five roles, engaging anti-ship missiles, aircraft, small surface vessels, drifting mines and unprotected targets ashore. The AO-18 weapon is a water-cooled, six-barrelled, Gatling-principle weapon with fixed breech block and revolving barrels. The weapon is believed to operate in a similar manner to that of the Phalanx, firing bursts of up to 400 rounds, but unlike the US weapon AK-630 features a separate radar director, although it is believed that the installation aboard the carriers slaves the AK-630s to the CADS-1 system.

Specifications
Calibre: 30 mm
Length of barrel: 65 calibres
Number of barrels: 6
Muzzle velocity: 890 m/s (2,920 ft/s)
Cooling: Water
Traverse: 360° at 70°/s
Elevation: −12 to +88° at 50°/s
Crew: 1 (off mount)
Range: 4,000 m (4,374 yd) (radar fire control); 5,000 m (5,470 yd) (electro-optic fire control)
Rate of fire: 4,000-5,000 rds/min
Magazine: 2,000 rds
Weight of complete round: 1.224 kg (2.70 lb)

Ammunition types
UOF-84 HE-I weight: 384 g (13.5 oz)
UOR-84 HE-T weight: 388 g (13.68 oz)
Fuze: MG-32 point impact (both rounds)

ANTI-SUBMARINE MORTARS

RBU-12000
Two RBU-12000 (*Raketnaya Bombometnaya Ustanovka* — rocket depth-bomb launcher) is the largest in a family of such ASW weapons fitted to most Russian surface warships and was introduced with this ship. The two launchers are installed forward on the forecastle.

Specifications
Tubes: 10
Range: 12,000 m (6.5 n miles)
Warhead: 80 kg (176.4 lb)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

4 Wine Flask (intercept)
8 Foot Ball
4 Bell Nip
4 Bell Thump
2 Cage Pot.

DECOYS

Two PK-2 twin chaff launchers
Towed torpedo decoy.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

3 Tin Man optronic trackers
2 Punch Bowl Satcom for SSM datalink
2 Low Ball Satnav
1 Bob Tail
IFF: 2 Salt Pot A and B. 1 Long Head.

RADARS

Type	Sky Watch*	Plate Steer	Strut Pair (two)	Palm Frond (three)	Fly Trap	Cake Stand
Role	3D Air Search	Air/Surface Search	Surface Search	Navigation	Aircraft Control	
Band		E	F		G/H	

*This set is non-operational

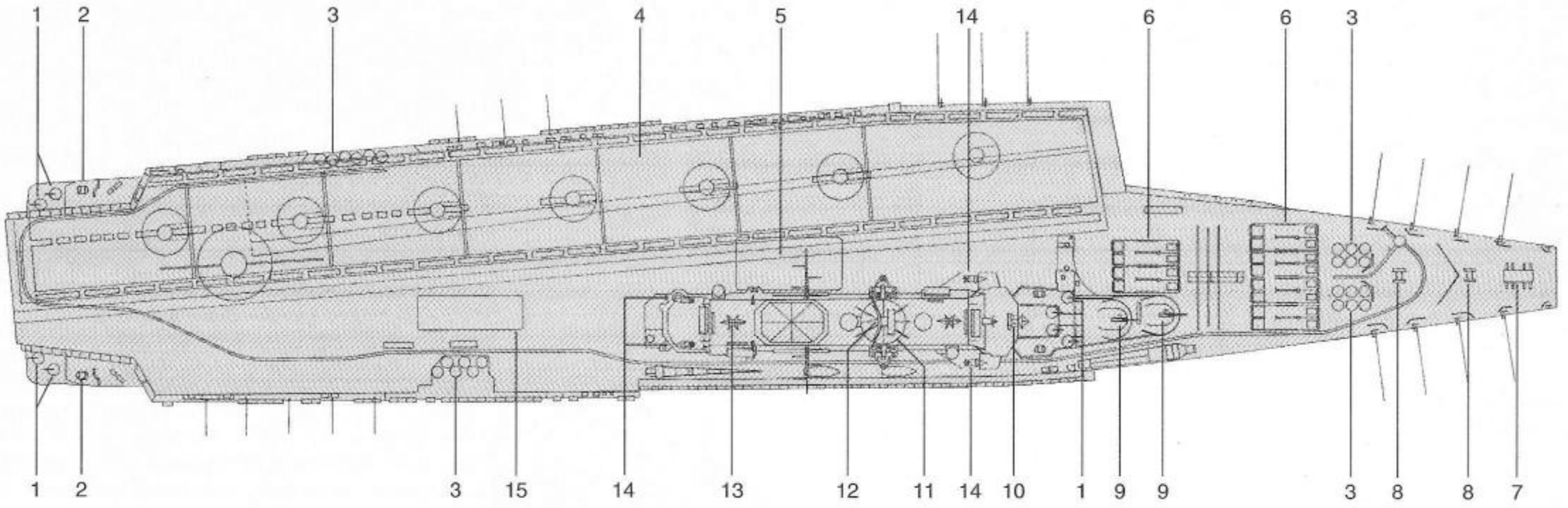
Fire Control Radars

Type	Trap Door	Kite Screech	Bass Tilt (four)	Cross Sword (four)
Role	SS-N-12	100 mm guns	Gatlings	SA-N-9
Band		H/I/K	H/I	K

SONARS

Horse Jaw; hull-mounted; active search and attack; low/medium frequency.
Horse Tail; VDS; active search; medium frequency.

AVIATION



Admiral Gorshkov (Ian Sturton)
1 *30 mm/65, 6-barrel CIWS* **2** *Bass Tilt* **3** *SA-N-9 six-tube vertical launchers* **4** *Flight deck* **5** *Forward elevator* **6** *SS-N-12 Sandbox (two twin) launchers* **7** *Trap Door (for SS-N-12)* **8** *RBU-12000 ASW rocket launcher* **9** *Single 100 mm/59 gun* **10** *Kite Screech* **11** *Cake Stand* **12** *Plate Steer* **13** *Strut Pair* **14** *Cross Sword* **15** *After elevator*

AVIATION FACILITIES

Specifications
Flight deck: 195 × 20.7 m (640 × 68 ft)
Angled deck: 4.5°
Elevators: 2, one abreast superstructure, 19.2 × 10.4 m (63.0 × 34.0 ft); one abaft superstructure, 18.5 × 4.7 m (60.7 × 15.4 ft)
Freeboard: 12.95 m (42.5 ft)

FIXED-WING AIRCRAFT

The 'Kiev' class originally carried 12 Yakovlev Yak-38 Forger, which was to have been replaced by the Yakovlev Yak-141 (Freestyle). The former was, however, taken out of service in 1992 and the latter has been cancelled. If, therefore, *Gorshkov* should go to sea again it will be as a helicopter carrier.

Kamov Ka-27/-29 (NATO = Helix)

The air wing will probably consist of 20-24 helicopters, a likely composition being: 19 Kamov Ka-27PL Helix A ASW helicopters, 2 Kamov Ka-32PS Helix-D SAR, and 3 Ka-25 Hormone B for over-the-horizon targeting for the SS-N-12 missiles. The Kamov series, with their unique contrarotating, coaxial rotors, are the standard ship-borne helicopters of the Russian Navy.

Specifications
Rotor diameter: 15.90 m (52.16 ft)
Rotor disc area: 397 m² (4,275 sq ft)
Fuselage length: 11.30 m (37.07 ft)
Height to rotor head: 5.40 m (17.72 ft)
Operating weight, empty: 6,500 kg (14,330 lb)
Max take-off weight: 12,600 kg (27,778 lb)
Max payload: 5,000 kg (11,023 lb)
Max level speed at optimum altitude: 135 kts (250 km/h)
Endurance: 4.5 h
Engines: 2 Klimov (Isotov) TV3-117V turboshafts, each 1,645 kW (2,205 shp)
Accommodation:
Ka-27PL: pilot plus 2
Ka-27PS: pilot plus 2
Ka-29TB: pilot, plus 2 crew plus 16 troops
Sensors:
Ka-27PL: surface-search radar, sonobuoys, dipping sonar
Ka-27PS: surface-search radar
Ka-29TB: electro-optical device (possibly combined FLIR/low-light TV), search radar, missile guidance radar
Ka-29RLD: large surface-search radar
Weapons:
Ka-27PL: torpedoes (3), nuclear or conventional depth bombs or mines
Ka-29TB: UV-57 rocket pods (2 × 32)

PROPULSION

The propulsion system for the 'Kiev' class was created by simply installing two of the units used in the 'Moskva' class, each consisting of four boilers and two turbines and driving two shafts.

Specifications
System: Steam turbines
Boilers: 8
Turbines: 4
Power output: 147 MW (200,000 hp(m))
Shafts: 4

FURTHER INFORMATION

PROGRAMME

Following construction of the first two helicopter cruisers of the 'Moskva' class, which were commissioned in 1967 *(Moskva)* and 1969 *(Leningrad),* work was started on a new and much larger class. The first of these, *Kiev,* was laid down in 1970 and commissioned in 1975, followed by *Minsk,* which was virtually identical, in 1978, and the third, *Novorossiysk,* which had some major differences, in 1982. There was then a gap of five years until the fourth, *Gorshkov,* joined the fleet, and which had so many changes that it is officially designated by NATO as the one-ship 'Modified Kiev' class.

The primary mission for which the 'Kiev' class carriers were designed was the protection of the Soviet Union's 'SSBN bastions': the Barents Sea in the west and the Sea of Okhotsk in the east. They might also have undertaken offensive operations against NATO ASW barrier forces in areas such as the Greenland-Iceland-United Kingdom (GIUK) gap. Their air wing comprised some 17 helicopters and 13 Yakovlev Yak-38 (NATO = Forger) V/STOL aircraft.

For Western designers an aircraft-carrier has always been a ship in which the flight deck is the predominant external feature, with weapons systems being confined to a relatively few close in defensive systems, since the air wing is considered to be the primary offensive system. From *Moskva* onwards, however, Soviet and Russian designers have always used the carriers as platforms for a large selection of weapons systems.

NAME

All four ships were originally named after large cities in the (then) Soviet Union. The final ship of the class was thus named *Baku,* but when this became politically unacceptable it was changed to *Admiral Flota Sovietskogo Sojuza Gorshkov.*

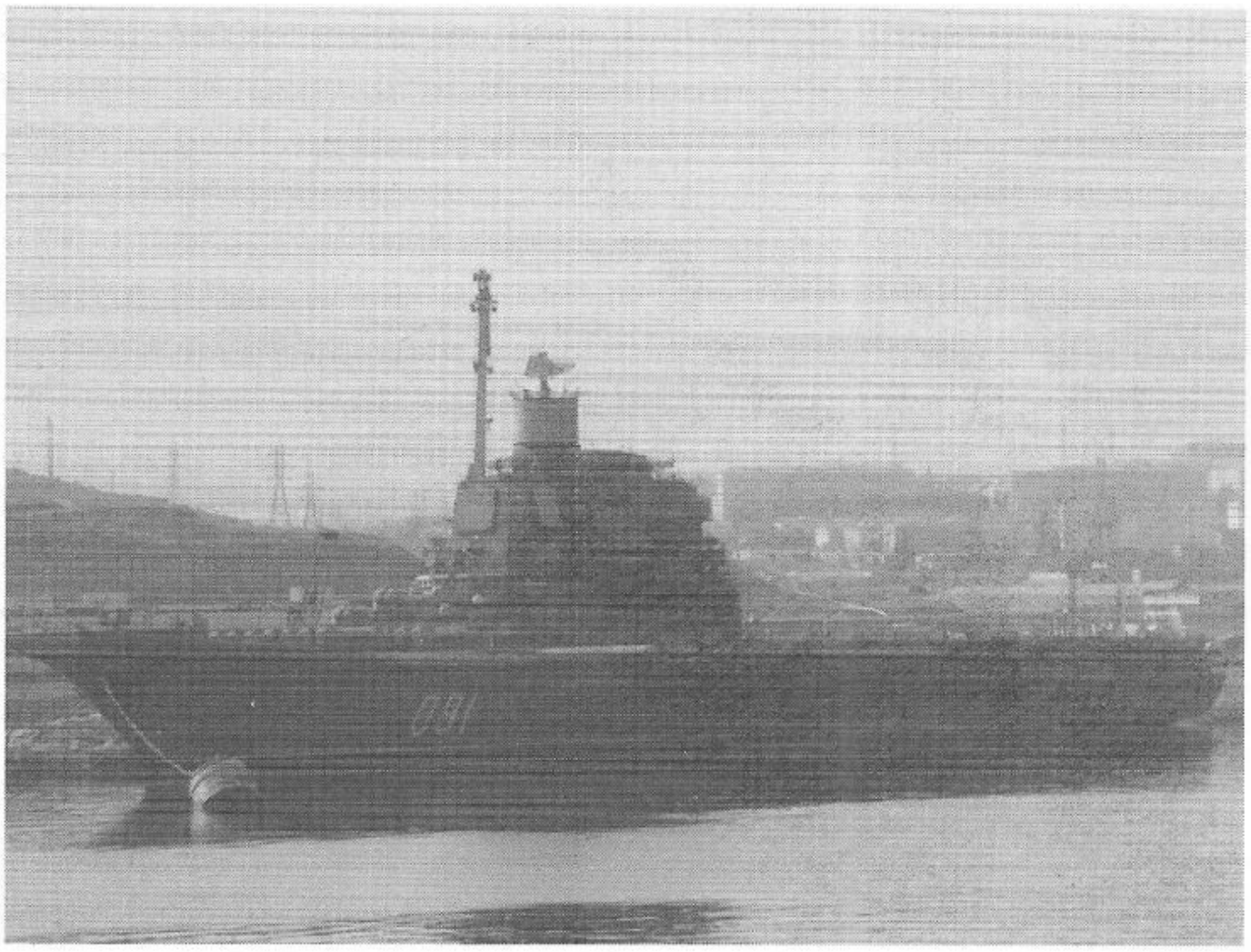
DESIGN

The basic design of the *Gorshkov* is the same as that of the three earlier ships, with a large, conventional superstructure to starboard and a foredeck covered with weapons. The flight deck is offset to port at an angle of some 4.5° and, since it lacks catapults, arrester wires or a ski-ramp it is suitable only for vertical or very short rolling take-offs by V/STOL aircraft. Active fin stabilisers are fitted and a blast shield is fitted in the transom to deflect the blast from the V/STOL aircraft as they come in over the stern for landing.

Weapon fit differed substantially as the class

developed. The first two ships had almost identical fits, but there were some changes in *Novorossiysk*. The most important changes were, however, in *Gorshkov,* whose fit resembled more that of the later *Kuznetsov;* see table below.

Weapon system	Role	*Kiev*	*Minsk*	*Novorossiysk*	*Gorshkov*
SS-N-12	Long-range anti-ship missiles	8	8	12	12
SA-N-3 (twin launchers)	Area air defence missile system	2	2	—	—
SA-N-4 (twin launchers)	Short-range air defense missile	2	2	—	—
SA-N-9	Vertical launch, short-range air defence missile	—	—	24	24
100 mm gun	Dual-purpose guns	—	—	2	2
76.2 mm gun	Dual-purpose guns	4	4	4	0
AK-230 30 mm/65 twin AA mount	Short-range gun system	4	4	4	—
AK-630 30 mm Gatling	Close in weapons system	—	—	—	8
533 mm (21 in) torpedo tubes	Anti-submarine torpedoes	10	10	0	—
SUW-N-1 ASW system	Anti-submarine	1	1	1	—
RBU-6000	Anti-submarine rocket launcher	2	2	2	—
RBU-12000	Anti-submarine rocket launcher	—	—	—	2



Admiral Gorshkov *in 1990*

SENSORS

There were also differences in sensors as the class developed, most of which resulted from changes in the weapons systems. *Gorshkov* did, however, introduce two major new sensors. The first of these was the Plate Steer 3-D planar array, with four large, fixed, rectangular arrays on the superstructure. The other innovation was the large Cake Stand TACAN (TACtical Air Navigation) array in a large cylinder 9 m (30.5 ft) high and 6 m (19.7 ft) in diameter atop the superstructure.

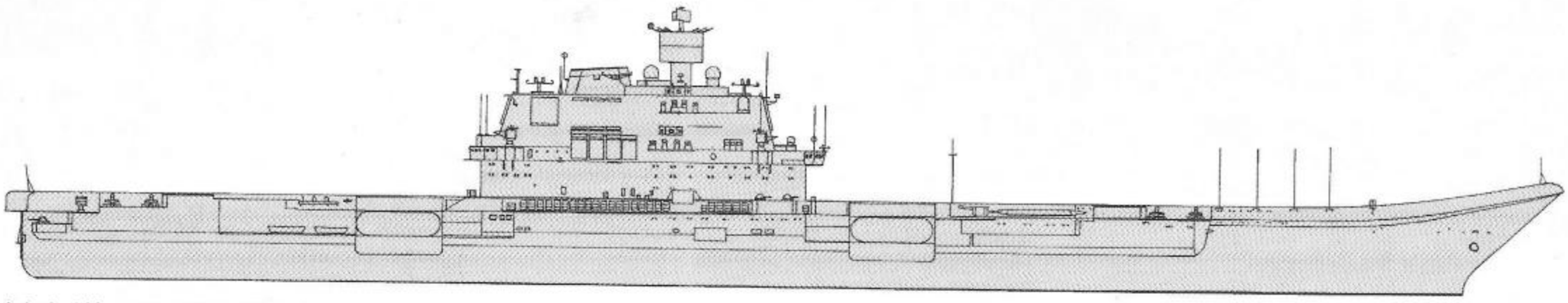
OPERATIONAL

All four carriers were built at Nikolayev in the Ukraine. *Kiev* deployed to the Mediterranean in July 1976 and then sailed to the Barents Sea, a voyage which was very closely shadowed by NATO ships, as the Alliance struggled to analyse the mission and capabilities of this new ship. *Kiev* returned to the Black Sea in late 1977 for repairs and modifications and then went back to the Northern Fleet. Second of class, *Minsk,* went to the Pacific Fleet in 1979, while the third, *Novorossiysk* joined *Kiev* in northern waters in 1982.

The reduction in East-West tension in the late 1980s signalled the beginning of the end for these ships. Of possibly greater significance, however, was the demise of the Yak-38 (Forger) in the early 1990s and the failure of the Yak-141 (Freehand) to enter production. This meant that there were no fixed-wing aircraft to operate from the class, which perforce became helicopter carriers.

Minsk was taken out of service in the Far East in 1989, and both *Minsk* and *Novorossiysk* relegated to the reserve in 1992. Both then suffered fires in early 1993 and have since been scrapped in Korea. *Gorshkov* suffered a boiler room explosion and subsequent fire on 2 February 1994 and entered the dockyard at Severomorsk in October 1994 for essential repairs. The ship was offered for sale to India in late 1994, but the offer was not taken up and it remains with the Northern Fleet, probably in reserve and will almost certainly be scrapped if no foreign buyer can be found. Name ship of the class, *Kiev,* is lying derelict at a shipyard in Murmansk to be available for cannibalisation for spares if it is decided to keep *Gorshkov* operational. It is an ignominious end to a class which only 15 years ago was considered to be at the forefront of naval progress and the very symbol of Soviet naval power.

KUZNETSOV



Admiral Kuznetsov (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: Russia
Type: Project 1143.5/6 *Takticheskiy Avionosnyy Kreyser* (TAKR); tactical aviation cruiser; aircraft carrier (CV). OREL-class (Type 1143.5) heavy aircraft-carrying cruiser

Class: KUZNETSOV

Active: 1
Building: 1
Proposed: 0

Displacement:
standard: 45,900 t
full load: 58,500 t

Length: oa 304.5 m (999 ft); wl 280 m (918.6 ft)
Beam: oa 70 m (229.7 ft); wl 37 m (121.4 ft)
Draught: 10.5 m (34.4 ft)

Speed: 30 kts

Complement: 1,700 (200 officers)

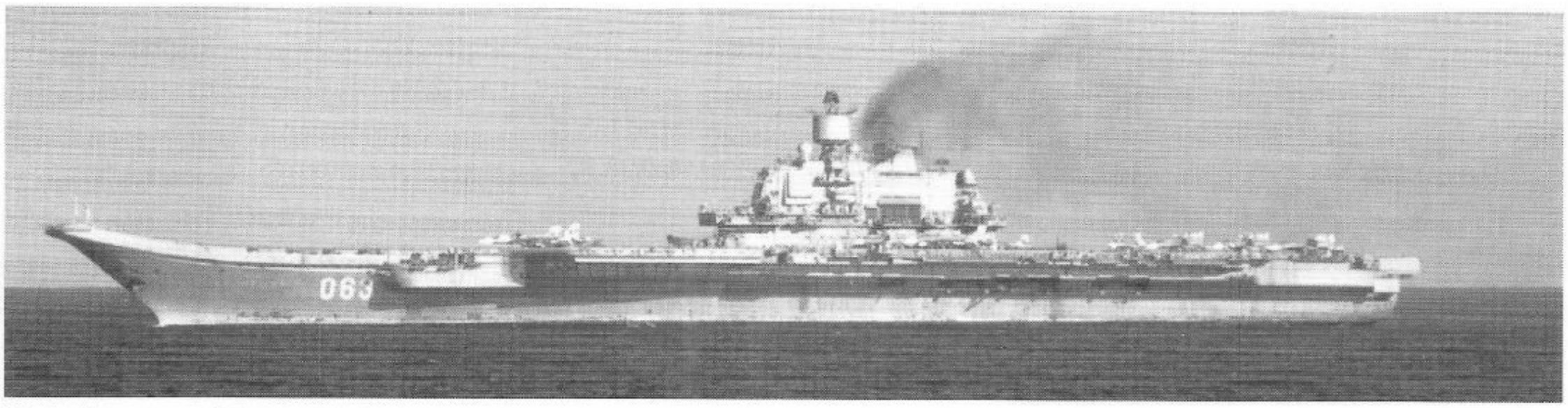
SHIPS

ADMIRAL FLOTA SOVETSKOGO SOYUZA KUZNETSOV

Builder	Chernomorsky Shipyard, Ukraine
Laid down	22 Feb 1983
Launched	5 Dec 1985
Commissioned	21 Jan 1991

VARYAG

Builder	Chernomorsky Shipyard, Ukraine
Laid down	8 Dec 1985
Launched	28 Nov 1988
Commissioned	—



Admiral Kuznetsov *off Malta in early 1996, en route to the Adriatic. This was the realisation of a Russian ambition, as a world-class aircraft carrier, with fixed-wing aircraft embarked, deployed in international waters* (Jane's/H M Steele)

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

P-500 Granit (NATO = SS-N-19 Shipwreck)

12 Granit (SS-N-19) anti-ship missile launch tubes are situated in six pairs under the forward flight deck, a unique location, typical of the imaginative thinking of Soviet warship designers. The missile is believed to have an inertial guidance system, possibly with provision for mid-course guidance in over-the-horizon (OTH) engagements, and active radar terminal guidance. The ships do not carry a missile guidance radar such as Front Door, the guidance task, instead, being carried out either by Tu-95 'Bear D' long-range reconnaissance aircraft, or the ship's Ka-27 'Helix B' helicopters with Big Bulge I/J-band radar, or Radar Ocean Surveillance Satellites (RORSAT), and it is noteworthy in the latter case that this class carries 'Punch Bowl' satellite communications systems. Targets can also be acquired by ship sensors, with bearing and range data being fed direct into the missile guidance system. Boosters take the missile in a ballistic trajectory which continues when the jet engine begins to operate, until it achieves an altitude of 20,000 m (65,000 ft) when it enters the cruise phase. The active radar seeker then acquires the target and the missile commences a high-angle dive attack. Some reports suggest the missile seeker may include a home-on-jam capability.

Specifications

Length: 10 m (32.8 ft)
Diameter: 85 cm (33.5 in)
Wing span: n/k
Weight: 3,250 kg (7,165 lb)
Speed: Mach 1.6 (some sources state Mach 2 or Mach 2.5)
Range: 20-450 km (10.8-243 n miles)
Guidance: Inertial with command update and active radar terminal guidance
Warhead: HE (750 kg); nuclear (500 kT) and/or fuel-air explosive (FAE)

Manufacturer/Contractor

NPO Mashinostroyenia, Russia.

SURFACE-TO-AIR MISSILES (SAM)

Kynshal (NATO = SA-N-9 Gauntlet)

There are four clusters of six vertical launchers for the Kynshal point air defence system, each with eight missiles, for a whole-ship total of 192 missiles. This system is designed for all-weather defence against aircraft, missiles and small craft and consists of the 9M330 missile, the handling-launcher system and the computer-based radar fire-control system. The missiles are launched vertically from eight-missile, cylindrical, launcher-containers with a gas ejection system, which carries them to a height of 18 to 20 m (59 to 65.6 ft) at which point the booster-sustainer comes into operation. The computer-controlled radar fire-control system is highly automated apparently using one computer for the 'Cross Sword' radar system and two to control the remainder of the Kynshal system and to interface with sensors.

Specifications

Length: 3.5 m (11.48 ft)
Diameter: 23.5 cm (9.25 in)
Wing span: 75 cm (29.5 in)
Weight: 165 kg (364 lb)
Speed: Mach 2.5
Range: 0.5-6.5 n miles (1.5-12 km)
Altitude: 6,000 m (19,685 ft)
Guidance: Command guidance, active radar homing
Warhead: 15 kg (33 lb) HE fragmentation warhead
Fuzes: RF, proximity, impact

Crew: 13 (complete system)
Targets: A maximum of 8 missiles can be controlled to engage a maximum of 4 Mach 2 targets simultaneously
Availability:
from cold-start: 3 min
from alert: 15 s
Response time: 8-24 s (depending on the search radar mode of operation)

Manufacturers/Contractors
Altair Research and Development Corporation, Russia (system).
Fakel, Kaliningrad, Russia (missile).

GUN/MISSILE SYSTEMS

Kashtan (NATO = CADS-N-1)
The Kashtan close in air defence system (CADS-N-1) is designed for point defence against anti-ship missiles and guided bombs. This weapon consists of a deck-mounted combat module on either side of which is a water-cooled 2A38M 30 mm gun (which is also used in the 2S6M Tunguska) and four launch tubes for solid-propellant, two-stage 9M311 (NATO = SA-N-11) missiles. Targets are probably designated through the ship's prime air search radar and then acquired by the CADS-N-1 'Hot Flash' search radar. Engagement takes place at ranges of between 1,500 and 8,000 m (4,921.5 and 26,248 ft), using radar or TV tracking, with the missiles probably launched in pairs for increased kill probability. The guns then engage any targets which have penetrated the missile barrier at ranges down to 500 m (1,640 ft). According to Russian sources the system is highly automated and can engage up to six targets per minute.

Specifications
SA-N-11
Length: 2.56 m (8.4 ft)
Diameter: 17 cm (6.7 in)
Weight: 57 kg (126 lb)
Speed: Mach 2.6
Range: 4.5 n miles (8 km)
Guidance: Radar to command-line-of-sight
Warhead: 8 kg (17.6 lb) fragmentation/multiple rod type
Fuze: Proximity activated within 5 m (16 ft) of the target

2A38M gun
Barrel length: 3.48 m (11.4 ft)
Barrel weight: 223 kg (492 lb) (with filled water jacket)
Cyclic rate of fire: 1,950-2,500 rds/min/barrel
Muzzle velocity: 960 m/s (3,150 ft/s)
Range: 2 n miles (4 km)
Altitudes: 200-2,000 m (219-2,190 yd)
Magazine: 1,900 rds

Manufacturer/Contractor
Tulamashzarod Joint Stock Company, Russia.

GUNS

AK-630 30 mm/65 Gatling CIWS
Six 30 mm 65-calibre AK-630 Gatling close in weapon systems. These have five roles, engaging anti-ship missiles, aircraft, small surface vessels, drifting mines and unprotected targets ashore. The AO-18 weapon is a water-cooled, six-barrelled, Gatling-principle weapon with fixed breech block and revolving barrels. The weapon is believed to operate in a similar manner to that of the Phalanx, firing bursts of up to 400 rounds, but unlike the US weapon AK-630 features a separate radar director, although it is believed that the installation aboard the carriers slaves the AK-630s to the CADS-1 system.

Specifications
Calibre: 30 mm
Length of barrel: 65 calibres
Number of barrels: 6
Muzzle velocity: 890 m/s (2,920 ft/s)
Cooling: water
Traverse: 360° at 70°/s
Elevation: −12 to +88° at 50°/s
Crew: 1 (off mount)
Range: 4,000 m (4,374 yd) (radar fire control); 5,000 m (5,470 yd) (electro-optic fire control)
Rate of fire: 4,000-5,000 rds/min
Magazine: 2,000 rds
Weight of complete round: 1.224 kg (2.70 lb)
Ammunition types:
UOF-84 HE-I weight: 384 g (13.5 oz)
UOR-84 HE-T weight: 388 g (13.68 oz)
Fuze: MG-32 point impact (both rounds)

Manufacturer/Contractor
Tulamashzarod Joint Stock Company, Russia.

ANTI-SUBMARINE MORTARS

RBU-12000
Two RBU-12000 (*Raketnaya Bombometnaya Ustanovka* — rocket depth-bomb launcher) is the largest in a family of such ASW weapons fitted to most Russian surface warships. In *Kuznetsov* the two launchers are installed on sponsons aft, just below the level of the flight deck.

Specifications
Tubes: 10
Range: 6.5 n miles (12,000 m)
Warhead: 80 kg (176.4 lb)

Manufacturer/Contractor
Sonerch, Russia.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Bell Push: 2
Foot Ball: 8
Wine Flask (intercept): 2
Flat Track: 2

ELECTRONIC COUNTERMEASURES (ECM)

PK-10 decoy system
PK-10 is a naval decoy system about which details were first received in 1993. It consists of KT-216 launchers, a control console and munitions. There are 10—120 mm barrels fixed at about 45°.

Manufacturer/Contractor
Institute of Applied Physics, Moscow, Russia.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS AND DATALINKS

Little is known about the ship's communications systems, apart from the external evidence of the antennas, which show that the ship has the usual HF, VHF and UHF systems. Specific antenna arrays identified are:

Satcom datalink
Low Ball Satnav arrays: 2
Bell Crown datalink: 2
Punch Bowl arrays for receiving over-the-horizon targeting data: 2

WEAPONS CONTROL

Tin Man optronic trackers: 4
Punch Bowl: 2
Aircraft control: Fly Trap B; G/H band
Tacan: Cake Stand
IFF: Four Watch Guard.

RADARS

Type	Sky Watch* (*Kuznetsov*)	Top Plate	Strut Pair** (two)	Palm Frond (three)	Cross Sword	Hot Flash	Fly Trap B
Role	3D Air search	Air search	2-D Air search	Navigation	Fire control for SA-N-9	Fire control for SA-N-11	Aircraft control radar
Band	E/F	D/E	F	I	K/C		
Peak Power		30 kW					
Typical Range		Can detect 7 m^2 target at 5,000 m at range of 130 km; 0.05 m^2 missile at 30 km	Can detect 2 m^2 medium-altitude target at 60 n miles (110 km)				

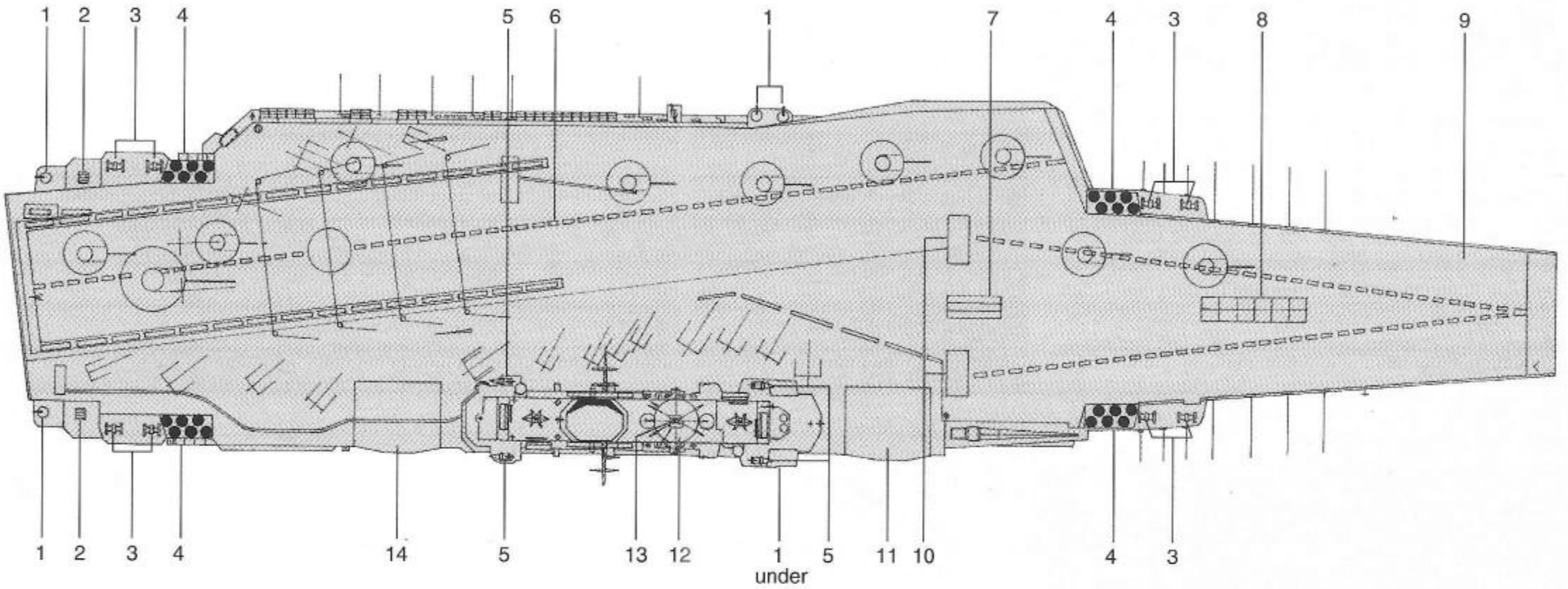
Notes
* This fixed, planar array radar uses four fixed antennas and is installed in *Kuznetsov*. It is not being installed in *Varyag* and it is suggested that the system has, in fact, been a failure
** Formed by positioning two Strut Curve antennas back to back

SONAR

Horse Jaw

A Horse Jaw medium-/low-frequency sonar is mounted in the hull.

AVIATION



Admiral Kuznetsov (Ian Sturton)
1 *AK-630, 6-barrelled, 30 mm CIWS* **2** *RBU 12000 ASW mortar* **3** *CADS-N-1 Kashtan twin 30 mm/eight SA-N-11* **4** *Sextuple SA-N-9 (Gauntlet) vertical launcher* **5** *Cross Sword fire control* **6** *Flight deck; 304.5 × 70 m (1,000 × 203 ft); 7°* **7** *Ammunition hoist* **8** *12 SS-N-19 (Shipwreck) vertical launchers* **9** *Ski ramp; 15°* **10** *Jet efflux deflection plates* **11** *Side elevator; 20 × 15 m (65.6 × 49.2 ft) (approx)* **12** *Cake stand TACAN* **13** *Top Plate air search radar* **14** *Side elevator; 20 × 15 m (65.6 × 49.2 ft) (approx)*

AVIATION FACILITIES

Specifications

Flight deck: 304.5 × 70 m (999 × 229.7 ft)
Height above sea level: 16.5 m (54.13 ft)
Angled deck: 7°
Ski ramp: 15°
Arrester wires: 4
Hangar: 186 × 29.8 × 7.6 m (610 × 98 × 25 ft)
Elevators: 2 starboard side forward and aft of superstructure; 20 × 15 m (65.2 × 49.2 ft); 40 t (approx) capacity
TACAN: Cake Stand TACAN (TACtical Air Navigation) system is mounted in a large cylindrical radome at the head of the mainmast immediately below the Top Plate antenna

Air wing

The Russian Navy claims that in war the air wing would total some 60 aircraft, while another Russian source suggests that the standard air wing was planned to be 52 aircraft: 18 Su-27K (Su-33) Flanker D; 18 MiG-29K and 16 Ka-27 helicopters. During peacetime deployments to date a maximum of 40 has been observed and with the demise of the MiG-29K, the air wing is more likely to consist of 20 Su-27K, 4 Su-25 UTG Frogfoot; and approximately 20 Ka-27/-29 Helix, of which two to three would be Ka-27RLD AEW, two to four would be Ka-27PS search and rescue; and the remainder Ka-27PL ASW type. Ka-29 troop carriers could also be part of the air wing if amphibious operations were planned.

FIXED-WING AIRCRAFT

Sukhoi Su-27K Flanker D

20 Sukhoi Su-27K (Su-33) (NATO = Flanker D). This aircraft competed with the MiG-29 for the order for the Russian Navy's first fixed-wing, carrierborne fleet air defence fighter.

Specifications

Wing span: 14.70 m (48.23 ft)
Length: 21.90 m (71.85 ft)
Height: 5.90 m (19.33 ft)
Operating weight, empty: 17,700 kg (39,021 lb)
Max take-off weight: 32,000 kg (70,546 lb)
Max internal fuel: 9,400 kg (20,723 lb)
Max weapon load: 6,500 kg (14,330 lb)
Max level speed at sea level: 739 kts (1,370 km/h)
Range at low altitude: 739 n miles (1,370 km)
Engine: 2 NPO Saturn (Lyulka) AL-31F turbofans, each 79.43 kN (17,857 lb) dry thrust, and 122.58 kN (27,557 lb) with afterburning
Accommodation: 1 (pilot)
Sensors: Track-while-scan pulse Doppler radar, IR scanner
Weapons: 1 × 30 mm cannon, 10 × AAMs (AA-12, AA-11, AA-8), or ASMs (Kh-41 Moskito; Kh-31 anti-radar; Zvezda Kh-35 anti-ship)

Sukhoi Su-25UBP Frogfoot

Four Sukhoi Su-25UBP (NATO = Frogfoot) attack aircraft. Designed as a ground-attack aircraft for the (then) Soviet Air Force, the Su-25 was later developed into the Su-25UT 2-seat trainer and the navy ordered ten fitted with hooks for use in training pilots for carrier operations, designated Su-25UTG (G = *Gak* = hook). This has subsequently been developed into the 2-seat naval attack aircraft Su-25UBP (P = *palubnyi* = shipborne).

Specifications

Wing span: 14.36 m (47.10 ft)
Length: 15.55 m (51.00 ft)
Height: 5.20 m (17.06 ft)
Operating weight, empty: 9,800 kg (21,605 lb)
Max take-off weight: 18,600 kg (41,005 lb)
Max fuel: 5,000 kg (11,023 lb)
Max weapon load: 4,000 kg (8,818 lb)
Max level speed at sea level (clean): 513 kts (950 km/h)
Attack radius: 267 n miles (495 km)
Engine: 2 MNPK Soyuz (Tumanskii) R-195 turbojets (44.13 kN (9,921 lb) each)
Sensors: Laser rangefinder, ESM, ECM
Weapons: 1 × 30 mm cannon, AAMs (AA-8), rockets, bombs

HELICOPTERS

Kamov Ka-27/-29 (NATO = Helix)

The Kamov series, with its unique contrarotating, coaxial rotors, is the standard shipborne helicopter of the Russian Navy. The *Kuznetsov* air wing normally includes about 20 of these aircraft, of which two to three are the airborne early warning variant, two to four are for search and rescue, and the remainder for ASW.

Specifications

Rotor diameter: 15.90 m (52.16 ft)
Rotor disc area: 397 m² (4,275 sq ft)
Fuselage length: 11.30 m (37.07 ft)
Height to rotor head: 5.40 m (17.72 ft)
Operating weight, empty: 6,500 kg (14,330 lb)
Max take-off weight: 12,600 kg (27,778 lb)
Max payload: 5,000 kg (11,023 lb)
Max level speed at optimum altitude: 135 kts (250 km/h)
Endurance: 4.5 h
Engines: 2 Klimov (Isotov) TV3-117V turboshafts, each 1,645 kW (2,205 shp)
Accommodation:
Ka-27PL: pilot plus 2
Ka-27PS: pilot plus 2
Ka-29TB: pilot, plus 2 crew plus 16 troops
Sensors:
Ka-27PL: surface search radar, sonobuoys, dipping sonar
Ka-27PS: surface search radar
Ka-29TB: electro-optical device (possibly combined FLIR/low-light TV), search radar, missile guidance radar
Ka-29RLD: large surface search radar
Weapons:
Ka-27PL: torpedoes (3), nuclear or conventional depth bombs or mines
Ka-29TB: UV-57 rocket pods (2 × 32)

PROPULSION

Specifications
System: Steam
Boilers: 8 turbo-pressurised

Turbines: 4 geared steam turbines
Power output: 147 MW (200,000 shp)
Shafts: 4

FURTHER INFORMATION

PROGRAMME

Plans for a Soviet Navy carrier, code-named '*Orel*' (Eagle) were laid in the early 1970s and two Orels were programmed for the 1976 Five Year Plan, but in 1979 the design was revised down to an expansion of the previous TAKR-type Project 1143. The first ship was laid down in 1983 and launched in 1985, but due to the end of the Cold War was not completed until 1991. *Varyag* built to a slightly modified Project 1143.6 design and was 70 to 80 per cent complete by early 1993, but has made little progress since then, despite the clear desire of the Russian Navy to complete her and bring her into service.

This is a logical progression of the 'Kiev' class and was justified domestically as mobile bases for fighters to extend the range of land-based air cover.

NAMES

These carriers' names suffered from shifts in political power in the USSR and, later, in the Russian Federation. The first of class was originally named *Riga,* but in 1982 this was changed to the (then) prestigious name *Leonid Brezhnev* and was launched under that name. When Brezhnev's memory fell into disfavour, however, the name was changed yet again, this time to *Tbilisi,* in 1987. The Russian Navy then found itself with its two most prestigious ships bearing names of cities in states seeking independence, so the names were changed yet again, with *Tbilisi* becoming *Admiral Flota Sovietskogo Sojuza Kuznetsov* (*Admiral of the Fleet of the Soviet Union Kuznetsov*, usually shortened to *Kuznetsov*) which it bears today. The second carrier was launched in 1988 as *Riga,* but when the Baltic States became independent this was changed to *Varyag*.

DESIGN

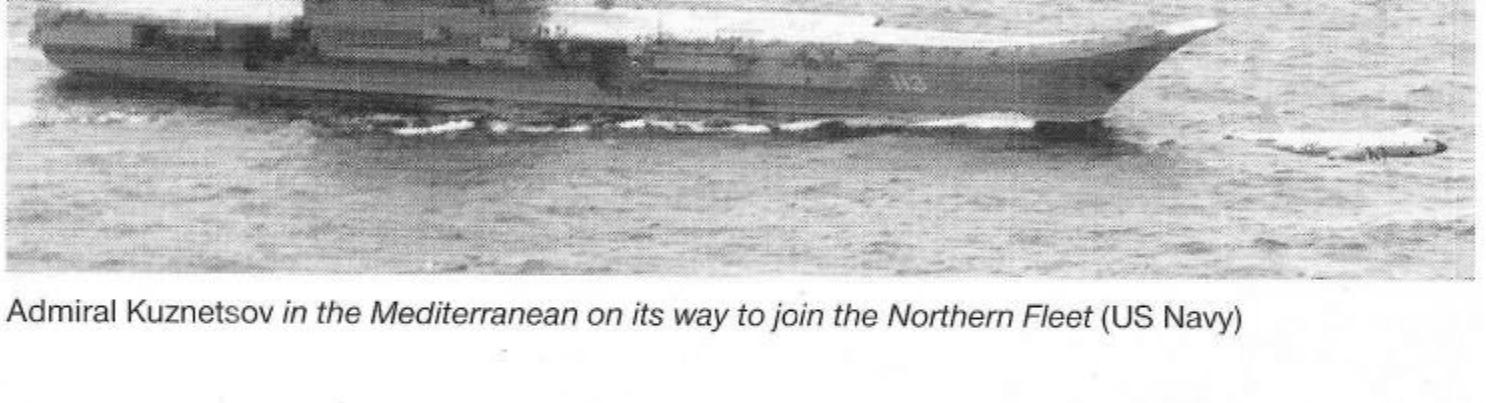
The most unusual feature of the design is the built-in 12° ski ramp. The ski ramp was originally developed for use by V/STOL aircraft as a means of increasing their payload, although it was recognised from an early stage that there was potential for use by CTOL aircraft. Indeed, trials were carried out at the US Naval Air Test Center, Patuxent River in the 1970s, using F-14s, but, although the take-offs were successful, the idea was not pursued. The Russians, however, took up the idea, because (according to Russian sources) they had problems in developing a workable steam catapult. One was actually constructed and trialled on land. However, 'the projectors failed to provide the requisite structural rigidity of the catapult track. Consequently, the track buckled when the cruiser was subjected to torsional loads on a rough sea and the catapult failed to function'.

There are two take-off runs, with three start points marked by jet efflux deflector plates. The starboard run is some 85 m (279 ft) long and starts just forward of the superstructure. The port run is some 170 m (558 ft) long, but has an interim start at the 85 m (279 ft) point. Although there are no catapults, there are 'special undercarriage catches' which hold the aircraft stationary until their afterburners have developed full thrust. Aircraft could take off from the starboard run at the same time as landings on the 7° angled deck, but the use of the port run would be impossible. According to Russian reports the power output of the engines of the Sukhoi Su-27K has been increased by some 10 to 12 per cent, presumably in order to improve take-off performance over the ski ramp and as a result the aircraft have been fitted with 'buddy' air-to-air refuelling packs.

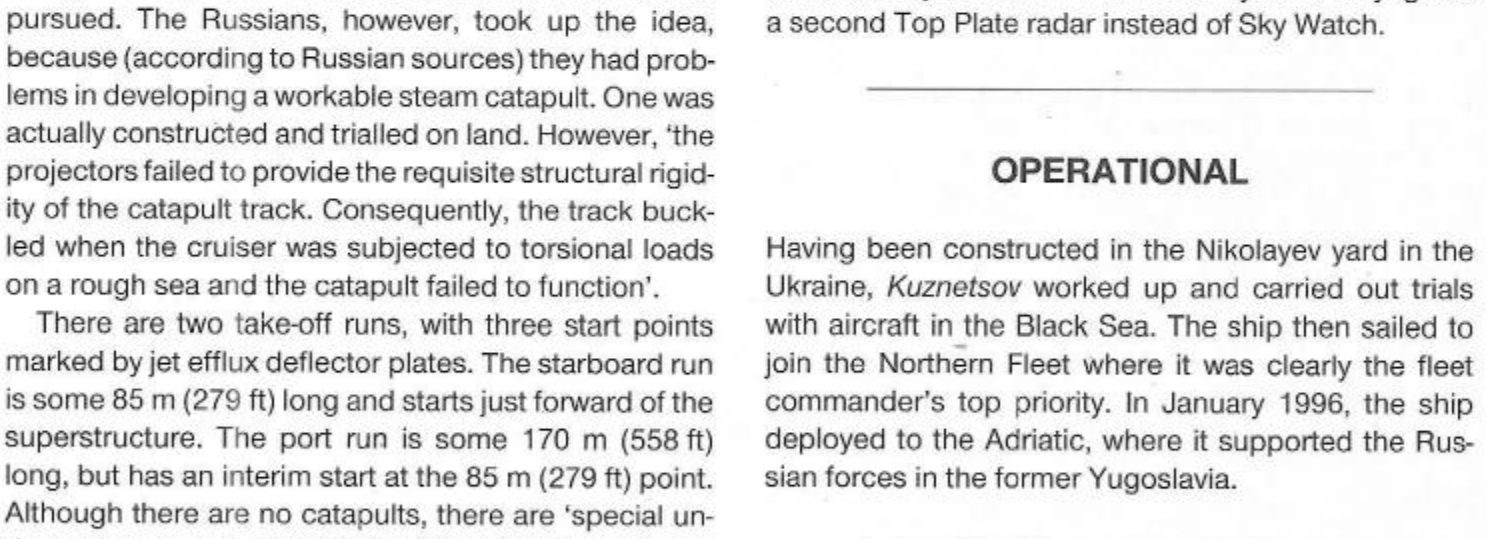
Landings are conventional, with an automatic radar-controlled system, a back-up mirror landing aid, and four arrester wires, located some 14 m (46 ft) apart.

The hangar is approximately 186 × 29.8 × 7.6 m (610 × 98 × 25 ft) and can hold up to 18 Flanker aircraft, although the SS-N-19 battery must take up a great deal of space which otherwise could be allocated to aircraft.

There are two starboard side lifts, a ski ramp of 12° and an angled deck of 7°. The SSM system is in the centre of the flight deck forward with flush deck covers. There is no Bass Tilt radar and the ADG guns are probably controlled by CADS-N-1 fire-control system. *Varyag* has a second Top Plate radar instead of Sky Watch.



Admiral Kuznetsov *seen with its original name of* Tbilisi. *The immense size of the superstructure and the great number of antennas is in marked contrast to Western carriers* (TASS)



Admiral Kuznetsov *in the Mediterranean on its way to join the Northern Fleet* (US Navy)

Admiral Kuznetsov's *flight deck is 304.5 m (1,000 ft) in length and 70 m (229.6 ft) wide, and the method of launching conventional take off aircraft over the ski ramp is unique. The huge cylindrical object above the superstructure is the Cake Stand TACAN system, with the Top Plate 1 air search antenna above it. Immediately above the bridge is one of the four rectangular planar arrays for the Sky Watch air surveillance systems* (US Navy)

OPERATIONAL

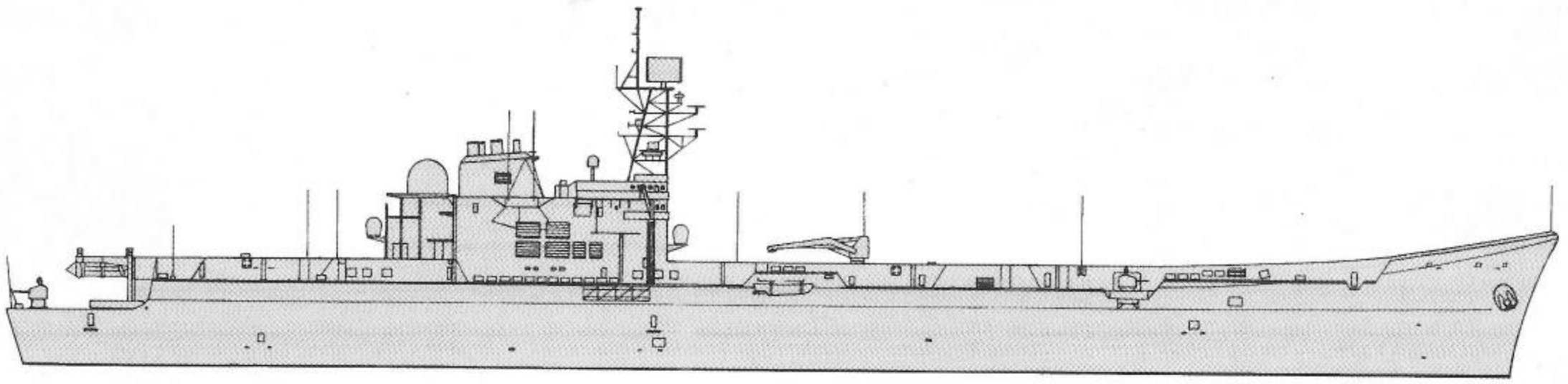
Having been constructed in the Nikolayev yard in the Ukraine, *Kuznetsov* worked up and carried out trials with aircraft in the Black Sea. The ship then sailed to join the Northern Fleet where it was clearly the fleet commander's top priority. In January 1996, the ship deployed to the Adriatic, where it supported the Russian forces in the former Yugoslavia.

THE FUTURE

A further design, the 65,000 ton nuclear-powered Type 1143.7, was laid down in November 1988 at Nikolayev. Originally named *Ulyanovsk*, this was later changed to *Pyotr Velikiy* (Peter the Great), but a variety of factors led to the cancellation of the ship in 1991 and it was scrapped when only 40 per cent complete. This ship would have been equivalent to contemporary large US Navy aircraft carriers and, among other differences from the *Admiral Kuznetsov,* would have been fitted with conventional steam catapults.

The Russian Navy still hopes to build a small force of Western-style aircraft carriers when national circumstances improve. These will be built in Russian yards.

PRINCIPE DE ASTURIAS



Principe de Asturias (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: Spain
Type: Aircraft carrier (CVS)

Class: PRINCIPE DE ASTURIAS

Active: 1
Building: 0
Proposed: 1 (?)

Displacement: full load 17,188 t
Length: oa 195.9 m (642.7 ft); pp 187.5 m (615.2 ft)
Beam: 24.3 m (79.7 ft)
Draught: 9.4 m (30.8 ft)

Speed:
main engines: 26 kts
auxiliary motors: 4.5 kts

Range: 6,500 n miles at 20 kts

Complement:
ship's company: 555 (90 officers)
air group: 201
Flag staff: 7 officers

SHIPS

PRINCIPE DE ASTURIAS (R 11)

Builder	Bazán, Ferrol, Spain
Laid down	8 Oct 1979
Launched	22 May 1982
Commissioned	30 May 1988

WEAPONS SYSTEMS

GUNS

Bazán Meroka

Four Bazán Meroka 12-barrelled 20 mm/120 close in weapons systems (CIWS). Meroka was developed entirely in Spain and is unique in its configuration and operation. The weapon itself consists of 12 Oerlikon 20 mm KAA barrels and uses standard Oerlikon 20 mm ammunition, but these barrels are arranged in a single unit of two superimposed rows of six with a common breech block. All operations, such as loading, feeding and unlocking, are carried out using compressed air from reservoirs on the mounting, which are recharged from an onboard compressor. Ammunition is brought to the barrels by two belt feeds, supplied by a hydraulically powered, rotating, 72-round magazine.

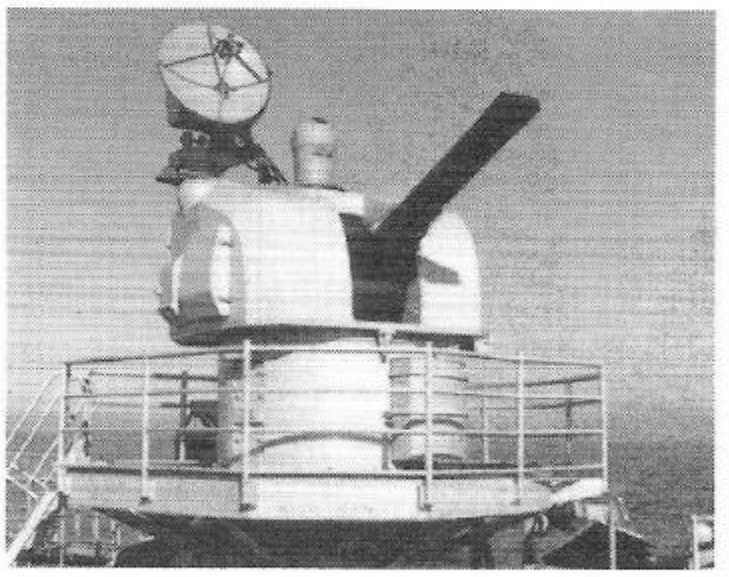
Specifications
Calibre: 20 mm
Length of barrel: 120 calibres

Muzzle velocity: 1,215 m/s (3,986 ft/s)
Traverse: 360° at 90°/s
Elevation: −20 to +85°
Crew: Nil
Range: 0.75 n miles (1.5 km)
Rate of fire: 2,700-3,600 rds/min
Ammunition: 337 g (TP-T, HEI, SAPHEI-T, AP-T); 310 g (APDS-T)

Manufacturer/Contractor
Fábrica de Artilleria de Bazán, Spain.

Rheinmetall 37 mm saluting guns

Two Rheinmetall 37 mm saluting guns.



The Meroka CIWS is a unique system, comprising 12 Oerlikon 20 mm barrels in two superimposed rows of six, with a common breech block. Rate of fire is between 2,700 and 3,600 rounds per minute (Bazán)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Elettronica Nettunel

Nettunel is a system for interception, direction-finding (DF) and jamming.

Manufacturer/Contractor
Elettronica SpA, Rome, Italy.

ELECTRONIC COUNTERMEASURES (ECM)

AN/SLQ-25 Nixie noisemaker

The AN/SLQ-25 Nixie is a solid-state, modular design electro-acoustic countermeasures decoy system used to protect the carrier from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 487.5 m (1,599.5 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408.24 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 94.6 cm (3.1 ft) long, 15.24 cm (0.5 ft) in diameter and weigh 18.14 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body at a time is deployed.

Manufacturer/Contractor
Aerojet ElectroSystems, USA.

DECOYS

Loral Hycor SRBOC

Two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units with two Mk 137 launchers.

Specifications

Launcher

Dimensions: 160 × 43 × 86 cm (5.2 × 1.4 × 2.8 ft)

Weight: 173 kg (381.5 lb)

Range: 2.2 n miles (4 km)

Rounds

Mk 182: 1,209 × 130 mm; 22.7 kg

Super Chaffstar: 1,209 × 130 mm; 20.9 kg

Super Gemini: 451 × 130 mm; 5.5 kg

Super Hiram III: 1,220 × 130 mm; 13.6 kg

Super Hiram IV: 467 × 130 mm; 3.8 kg

Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturers/Contractors

Loral Hycor Inc, USA.

Tracor Aerospace Inc (SCIP), USA.

COMMAND AND CONTROL SYSTEMS

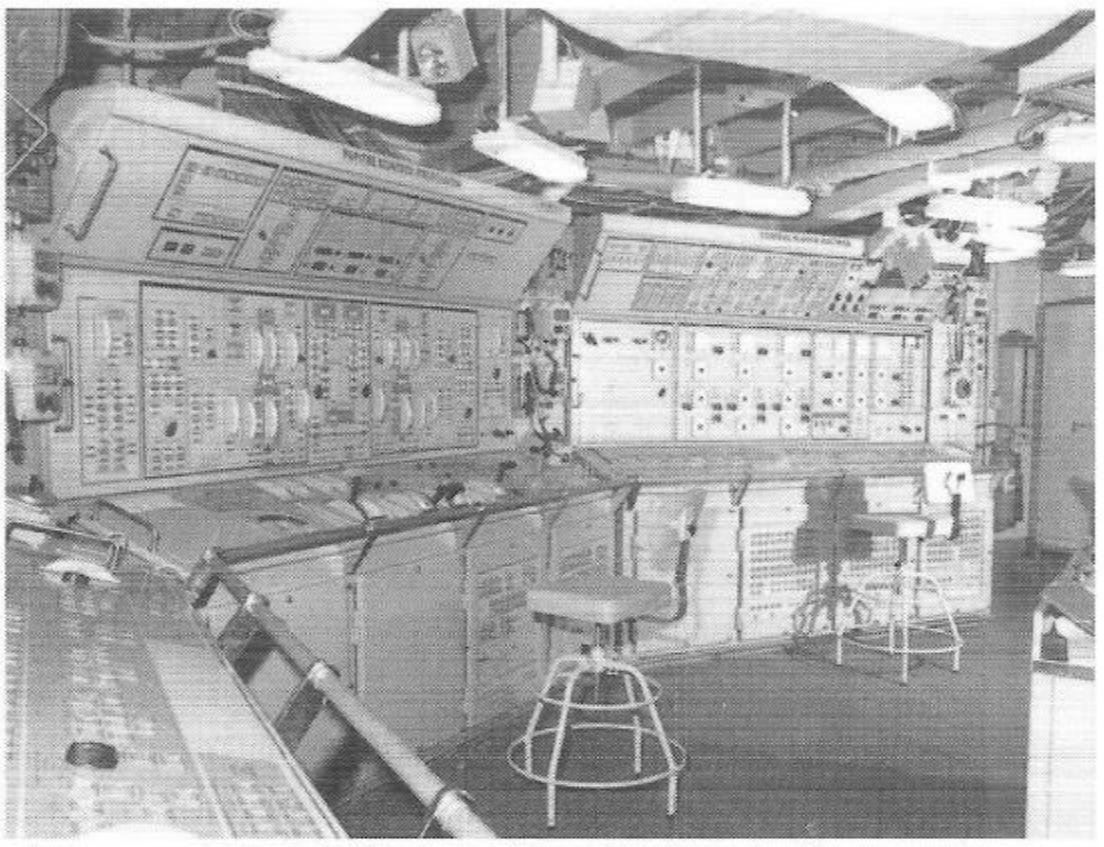
COMBAT DATA SYSTEMS

TRITAN

The TRITAN (Tratamiento Informatico de Tactica Naval) digital command and control system installed in *Principe de Asturias* is a mainframe system based upon two Unisys AN/UYK-7 processors, supported by a Unisys AN/UYK-20A computer, using the CMS-2M software language, with programs produced at the tactical programming and instruction centre at Rota, Spain. Other hardware includes a Selenia (now Alenia) radar central unit, a Quantex Model 2600 (AN/USH-26) signal recorder, a Genicom Model 2120, a CV-2953A signal data converter, a CV-2834 video radar processor and the Sainco-produced horizontal and vertical display systems known as 'Consolas TRITAN'. There is a data distribution system, Link 11 and Link 14 datalink hardware (the TE-237P terminal set and the 373E terminal set control) and the Ceselsa Deneb ESM subsystem. The system can track a total of 64 air and surface targets simultaneously together with four subsurface targets. The prime air search radar is the Hughes AN/SPS-52C, which has its own AN/UYK-20 computer. *Principe de Asturias* has no sonar system and it is believed the third horizontal console in this configuration is used for air traffic control in association with the ITT AN/SPN-35A aircraft control radar.

Manufacturer/Contractor

Direccion de Construcciones, Madrid, Spain.



Propulsion control centre (Bazán)

Principe de Asturias' *command centre* (Bazán)

RADARS

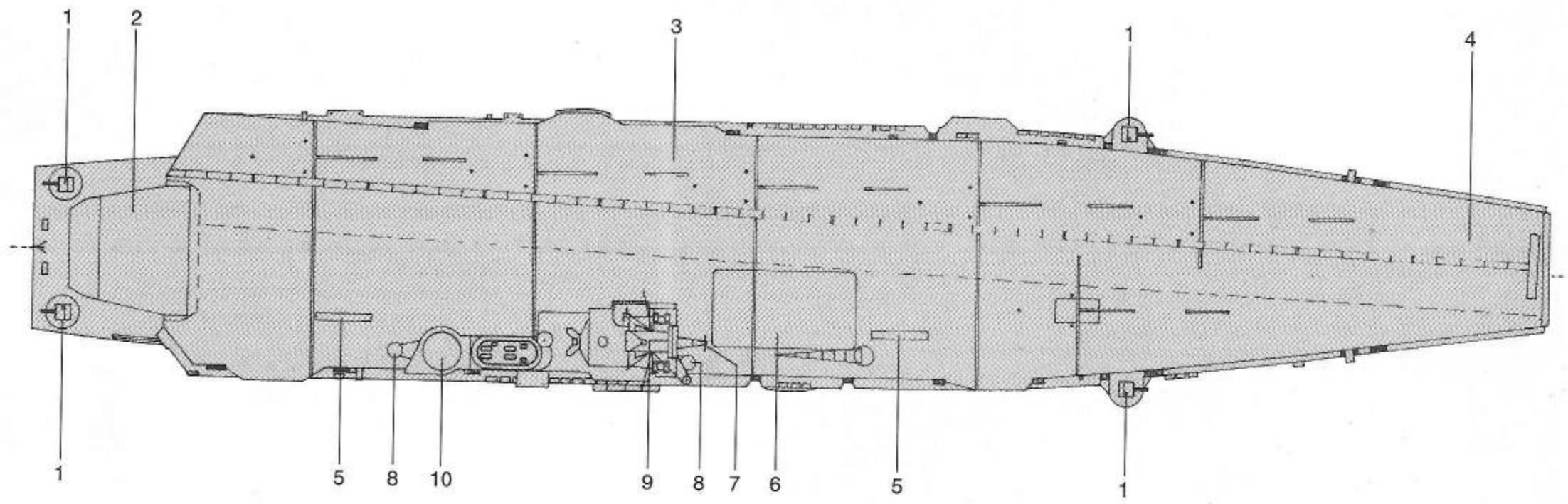
Type	SPS 52D	SPS 55	SPN 35A	VPS 2 (four)	RTN 11X	RAN 12L
Maker	Hughes	Cardion	ITT Gilfillan	Lockheed Martin	Selenia	Selenia
Role	3D	Surface search	Aircraft control	Fire control (Meroka)	Missile warning	Surface/low-flying search
Band	E/F	I/J	J	I	D/I	D/I
Beam	1.1 × 2.25°	1.5 × 20°	3 × 1.15	4° conical	D: 6.6 × 16° I: 1.1 × 6° plus csc²°	D: 6.6 × 16° I: 1.1 × 6° plus csc²°
Peak power	1,000 kW	130 kW	850 kW	1.4 kW	D: 0.3 kW I: 135/180 kW	D: 1.1 kW I: 135/180 kW
Gain	39.5 dB	31 dB	34 dB		D: 22 dB I: 35 dB	D: 22 dB I: 35 dB
Pulsewidth	2.5/4.6/10 µs	0.12/1.0 µs	0.2/0.8 µs		D: 2.9 µs I: 1.5/0.15 µs	D: 2.9 µs I: 1.5/0.15 µs
PRF	1,850/925 pps	2,250/750 pps	1,200 pps		D: 450-550 pps	D: 450-550 pps
Scan rate	15/6 rpm	16 rpm			15/30 rpm	15/30 rpm
Typical range	240 n miles (440 km)	n/a	aircraft targets at 50 n miles	sea-skimming missile/ aircraft — 2.5 n miles (5 km)	Fighter: low altitude >20 n miles; medium altitude >14 n miles	Fighter: low altitude >20 n miles; medium altitude >14 n miles

COMMUNICATIONS AND DATALINKS

Principe de Asturias carries the usual range of HF, VHF and UHF communications systems for ship-to-ship, ship-to-air and ship-to-shore links. Specific communications links include:

Link 11
Link 14
Marconi Matra SCOT 3 Satcom
Fleet Satcom.

AVIATION



Principe de Asturias (Ian Sturton)
1 *Meroka 12-barrelled 20 mm CIWS* **2** *Aft elevator* **3** *Flight deck 175.3 × 29 m (571 × 95 ft)* **4** *Ski ramp; 12°* **5** *Ammunition hoist* **6** *Forward elevator* **7** *ISC Cardion SPS 55 surface search radar* **8** *Marconi Matra SCOT 3 satellite antenna* **9** *Hughes SPS 52 C/D air search radar* **10** *ITT SPN 35A aircraft control radar*

AVIATION FACILITIES

Specifications

Flight deck: 175.3 × 29 m (575.1 × 95.1 ft)
Ski ramp: 12°
Elevators: 2 (1 centreline, aft; 1 starboard, forward)
Landing aid: Marconi Deck Approach Projector Sight (DAPS)
Hangar: 2,300 m² (24,748 sq ft)

Air wing

The normal maximum operational number of aircraft is 24, although a typical peacetime air wing comprises eight EAV-8Bs and 10 SH-60 Sea Hawks and Sea Kings, with two of the latter being AEW aircraft. In an emergency, the aircraft complement can be increased to 37, which involves parking on the flight deck.

FIXED-WING AIRCRAFT

McDonnell Douglas/BAe Harrier AV-8B Harrier II Plus

Specifications

Wing span: 9.25 m (30.33 ft)
Length: 14.12 m (46.33 ft)
Height: 3.55 m (11.89 ft)
Operating weight, empty: 6,336 kg (13,968 lb)
Max take-off weight:
short take-off (STO): 14,061 kg (31,000 lb)
vertical take-off (VTO): 8,596 kg (18,950 lb)
Max fuel:
internal: 3,519 kg (7,759 lb)
external: 3,661 kg (8,070 lb)
Max weapon load: 4,899 kg (10,800 lb) (with -406A engine)
Max level speed, low altitude: 575 kts (1,065 km/h)
Attack radius: 250 n miles (463 km; 288 miles)
Engine: 1 Rolls-Royce Pegasus F402-RR-408 turbofan (105.87 kN; 23,800 lb st)
Accommodation: 1 (pilot only, on Martin-Baker Mk 10H zero/zero rocket ejection seat)
Weapons: 30 mm guns, bombs, rockets and flares

HELICOPTERS

Sikorsky SH-3H Sea King

Six to 10 Sikorsky SH-3H Sea King helicopters are normally embarked, of which two will be in the airborne early warning (AEW) and the remainder in the anti-submarine warfare (ASW) roles.

Specifications

Main rotor diameter: 18.90 m (62.0 ft)
Length overall (both rotors turning): 22.15 m (72.66 ft)
Fuselage length: 16.69 m (54.75 ft)
Height to rotor head: 4.74 m (15.5 ft)
Rotor disc area: 280.5 m² (3,019 sq ft)
Max take-off weight: 9,525 kg (21,000 lb)
Internal cargo capacity: 2,720 kg (6,000 lb)
Max speed (never exceed): 144 kts (267 km/h)
Typical cruising speed: 120 kts (222 km/h)
Service ceiling: 3,720 m (12,200 ft)
Range with max standard fuel: 630 n miles (1,166 km)
Engines: 2–1,044 kW (1,400 shp) General Electric T58-GE-10 turboshafts. Normal fuel capacity 3,180 litres (840 US gallons)
Role equipment: Underwing pylons (6), torpedo bay, sonobuoy ports (32), depth charge racks (2), search radar, FLIR, MAD.
Accommodation: 4 (pilot, co-pilot, 2 sonar operators)
Sensors:
ASW: Low-frequency 360° AQS-13F sonar; Canadian Marconi LN66HP radar, ASQ-81 towed MAD bird
AEW: Thorn/EMI Searchwater radar
Weapons: Homing torpedoes or depth charges (not on AEW version)

Agusta-Bell AB 212ASW

Two to four Agusta-Bell AB 212ASW anti-submarine, anti-ship or electronic warfare helicopters are normally embarked.

Specifications

Main rotor diameter: 14.63 m (48.0 ft)
Length overall (both rotors turning): 22.15 m (57.08 ft)
Fuselage length: 12.92 m (42.39 ft)

Agusta Bell AB 212ASW on the Principe de Asturias' *flight deck. The large antenna above the bridge is for the Hughes SPS 52C/D* (Bazán)

Principe de Asturias *with a mix of AV-8S Matadors, EAV-8B Bravos and Sikorsky SH-3 Sea Kings on the flight deck. The AV-8S aircraft are to be sold to Thailand for deployment aboard* Chakri Naruebet (Bazán)

Height to rotor head: 3.91 m (12.82 ft)
Rotor disc area: 168.1 m² (1,809 sq ft)
Max take-off weight: 5,070 kg (11,177 lb)
Max speed (never exceed): 130 kts (240 km/h)
Typical cruising speed: 100 kts (185 km/h)
Hovering ceiling (out of ground effect): 396 m (1,300 ft)
Range with max standard fuel: 332 n miles (615 km)
Engine: 1 Pratt & Whitney Canada PT6T-6 Turbo Twin Pac rated at 1,398 kW (1,875 shp)
Role equipment: AS-12 ASMs or Elettronica Gufo 2000 EW intercept equipment

Sikorsky S-70B/SH-60B Sea Hawk (Spanish designation: HS.23)

Principe de Asturias normally embarks two HS.23 anti-submarine warfare and general purpose naval helicopters.

Specifications

Main rotor diameter: 16.36 m (53.66 ft)
Length overall (both rotors turning): 19.76 m (64.83 ft)
Fuselage length: 15.26 m (50.06 ft)
Height to rotor head: 3.63 m (11.91 ft)
Rotor disc area: 210.05 m² (2,262 sq ft)
Max take-off weight: 9,182 kg (20,244 lb)
Dash speed at 1,525 m (5,000 ft): 126 kts (234 km/h)
Typical cruising speed at sea level: 147 kts (272 km/h)
Operational radius: 50 n miles (82.5 km) for 3 h loiter/150 n miles (278 km) for 60 min loiter
Engine: 2 General Electric T700-GE-401 turboshafts, each rated at 1,260 kW (1,690 shp)
Accommodation: 3 (pilot, airborne tactical officer/co-pilot, sensor operator)
Sensors: APS-124 360° search radar; ASQ-81(V)2 towed MAD, ALQ-142 ESM, 25-tube sonobuoy dispenser
Weapons: Mk 46 lightweight torpedo (2)

PROPULSION

Specifications

Main propulsion system
System: Gas turbine
Main Machinery: 2 General Electric LM-2500 gas turbines
Power output: 34.61 MW (46,400 hp) sustained
Shafts: 1
Propeller: cp (controllable pitch)

Auxiliary propulsion system
System: Electric
Auxiliary motors: 2
Power output: 0.59 MW (800 hp(m)) (each)
Propellers: 2, retractable

FURTHER INFORMATION

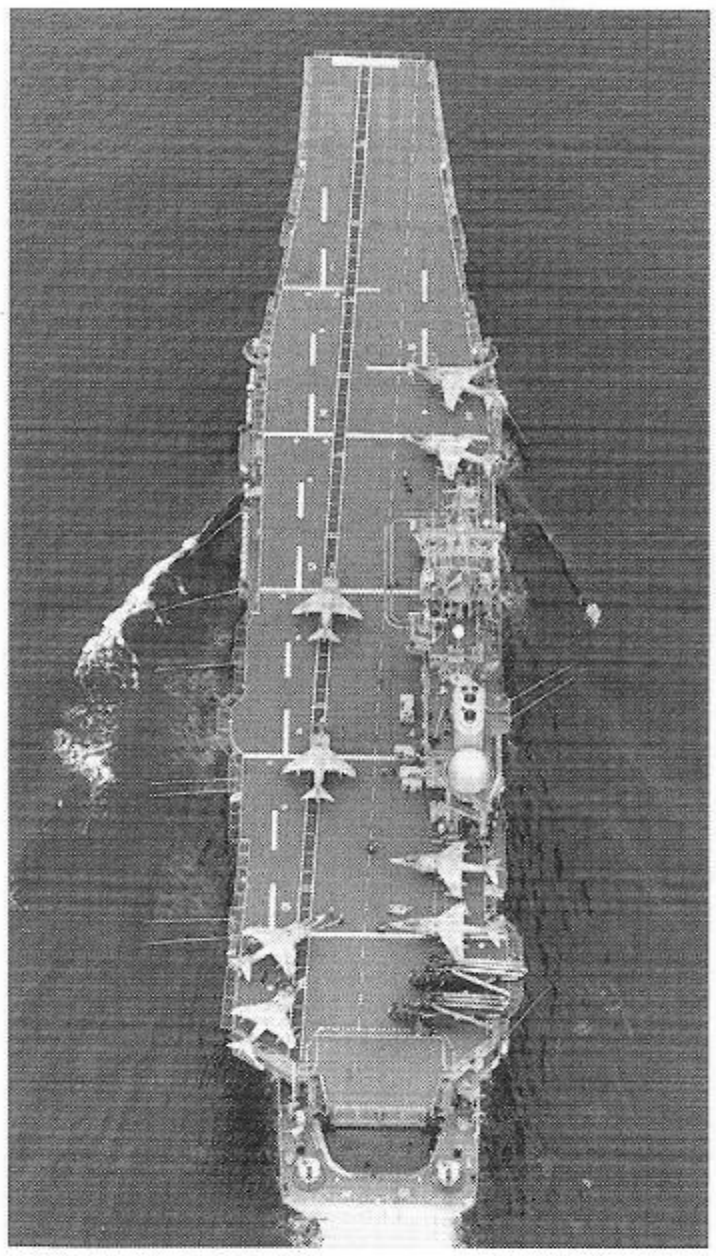
PROGRAMME

The first Spanish aircraft carrier was the *Dedalo* (the former US Navy 'Independence' class carrier *Cabot*), which was transferred in 1967 and purchased in 1973. This ship operated a mix of ASW helicopters (SH-3D Sea Kings and AB.212s) together with AV-8S Matadors (Spanish versions of the US Marine Corps' AV-8A), which for political reasons, were purchased from the USA rather than from the UK. *Dedalo* was, however, always seen as an interim measure, intended to fill a gap in the Spanish Navy's capabilities until a new aircraft-carrier, tailored to national requirements, could be built.

In the event, the Spanish Navy selected the US Navy's 'sea-control ship' (SCS) design. This had originally been developed as the 'low' end of a 'high/low' mix for the US Navy and had been intended for ASW and air superiority missions in low-threat areas. Being relatively small and unsophisticated by aircraft carrier standards, the SCS was intended to be cheap to build and maintain, and easy to operate. The US Navy eventually scrapped this plan in favour of more super-carriers, but the design met most of the Spanish Navy's needs. The ship was ordered in 1977, launched in 1982 and entered service in 1988, somewhat later than planned due to late changes in the command and control systems, and the addition of a Flag bridge. The carrier was originally to have been named *Canarias*, but this was later changed to *Almirante Carrero Blanco*, before the final change was made to *Principe de Asturias*, the hereditary title of the Crown Prince.

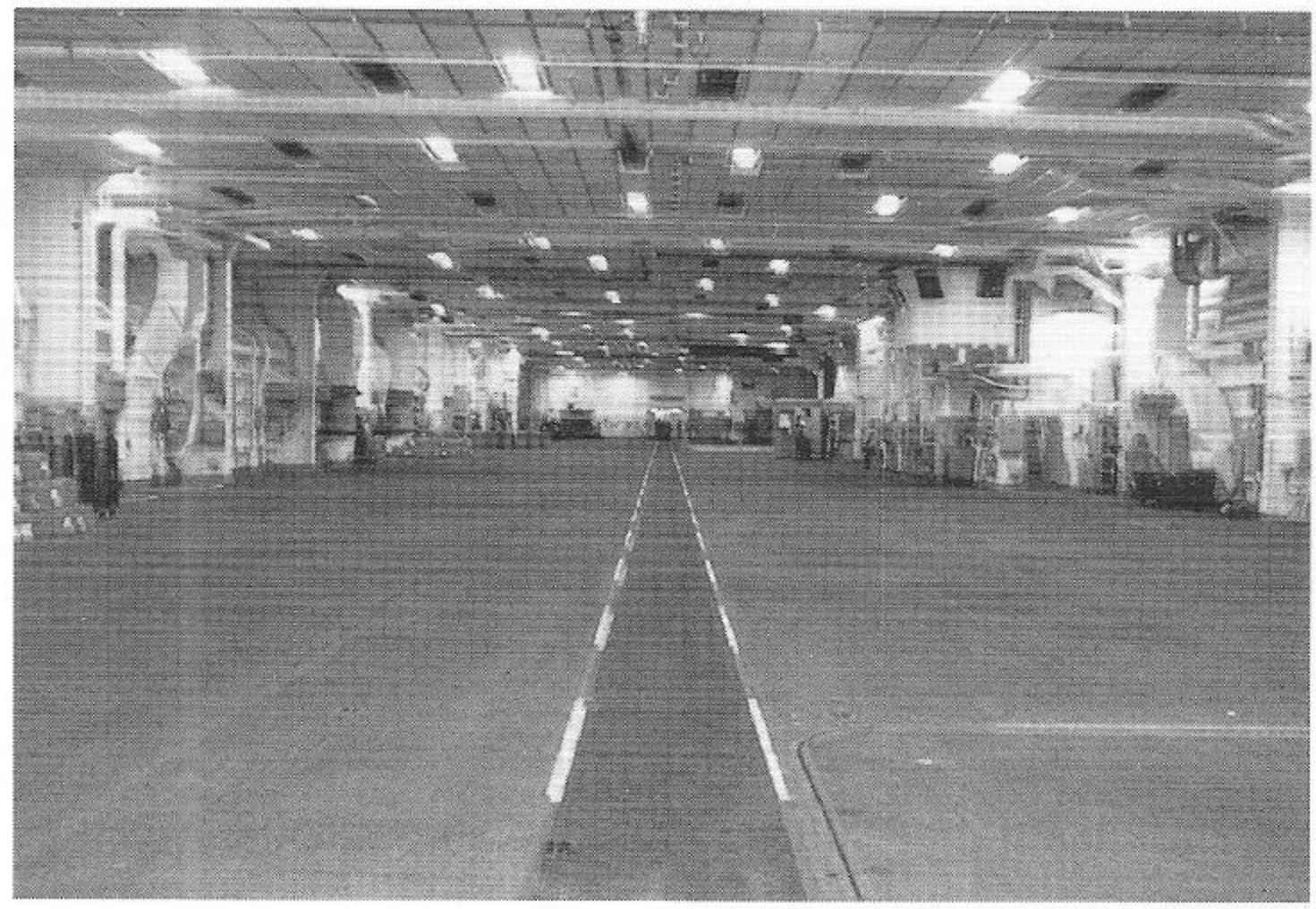
DESIGN

The ship is based on the US Navy's SCS and the Spanish Navy has resolutely tried to keep everything as simple as in the original, although one major change is the addition of a full-width 12° ski ramp, which enables the AV-8B and EAV-8B aircraft to carry out rolling take-offs



This overhead view of the Spanish carrier shows the flight track offset to port, the two elevators and the aircraft parking arrangements (Bazán)

Principe de Asturias *at sea with 'Baleares' class frigate* Asturias *(F 74), 'Santa Maria' class frigate* Reina Sofia *(F 84) and replenishment tanker,* Marques de la Ensada *(A 11)* (MoD Madrid)



The hangar has a 2,300 m² floor space (Bazán)

at full load. To maintain the policy of austerity, however, there is only a single propulsion shaft, and the electronic and weapons fits are limited by modern standards.

The ship is fitted with two pairs of Denny-Brown fin stabilisers and the US Prairie/Masker air-bubble system, which reduces the noise levels radiated by the hull and propellers.

An unusual feature is the auxiliary propulsion system, designed to give a 'get-you-home' service should the main system fail.

OPERATIONAL

The Spanish Navy seems to have invested well, having obtained a capable and flexible carrier at a reasonable price. Formally, the carrier is the flagship of the Spanish fleet, but operationally it is the flagship of 'Battlegroup Alfa', an ASW group originally intended to be part of NATO's defences in the North Atlantic. The ship's equipment includes two LCVPs, suggesting a limited amphibious capability. The ship is based at the main fleet base at Rota.

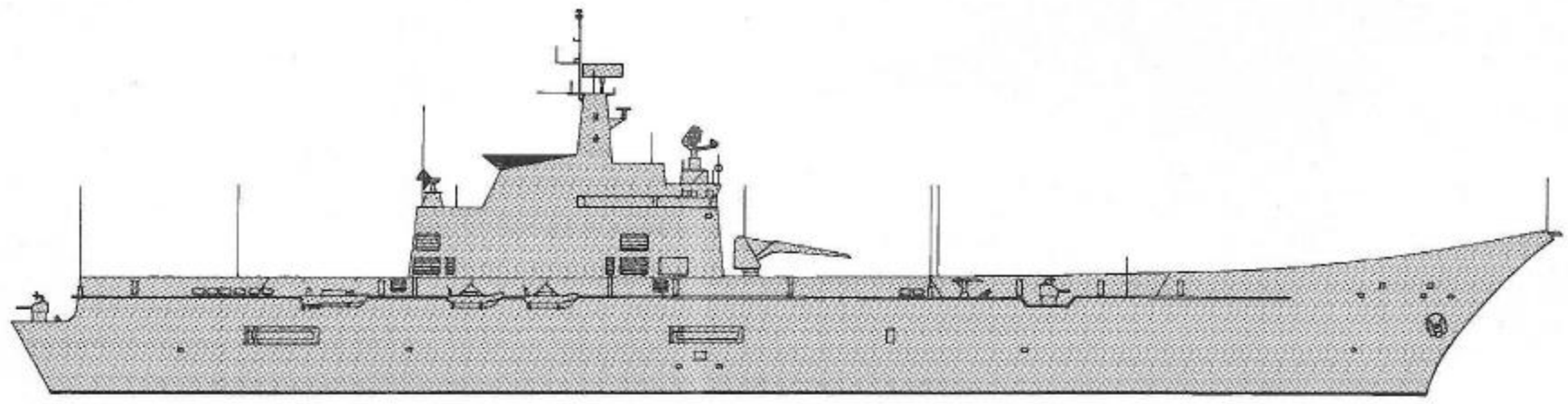
MODERNISATION

After two years' service the carrier returned to the dockyard in order to incorporate changes resulting from initial operating experience. The fuel system was improved and some modifications were made to the port after side of the island, in order to provide briefing rooms and sheltered parking space for flight deck vehicles. In addition, improved accommodation was added for six officers and 50 specialist ratings and a deck approach projector sight (DAPS) was installed.

THE FUTURE

The Spanish Navy has a known requirement for a second carrier, which would, presumably, be similar to the *Principe de Asturias* in size and general layout but would incorporate improvements resulting from experience with the earlier ship.

CHAKRI NARUEBET



Chakri Naruebet (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: Thailand
Type: Aircraft carrier (CVS)

Class: CHAKRI NARUEBET

Active: 0
Building: 1
Proposed: 0

Displacement: full load 11,485 t
Length: oa 182.6 m (599.1 ft); wl 164.1 m (538.4 ft)
Beam: oa 30.5 m (100.1 ft); wl 22.5 m (73.8 ft)
Draught: 6.16 m (20.21 ft)

Speed:
max: 26.4 kts
diesels: 16.7 kts

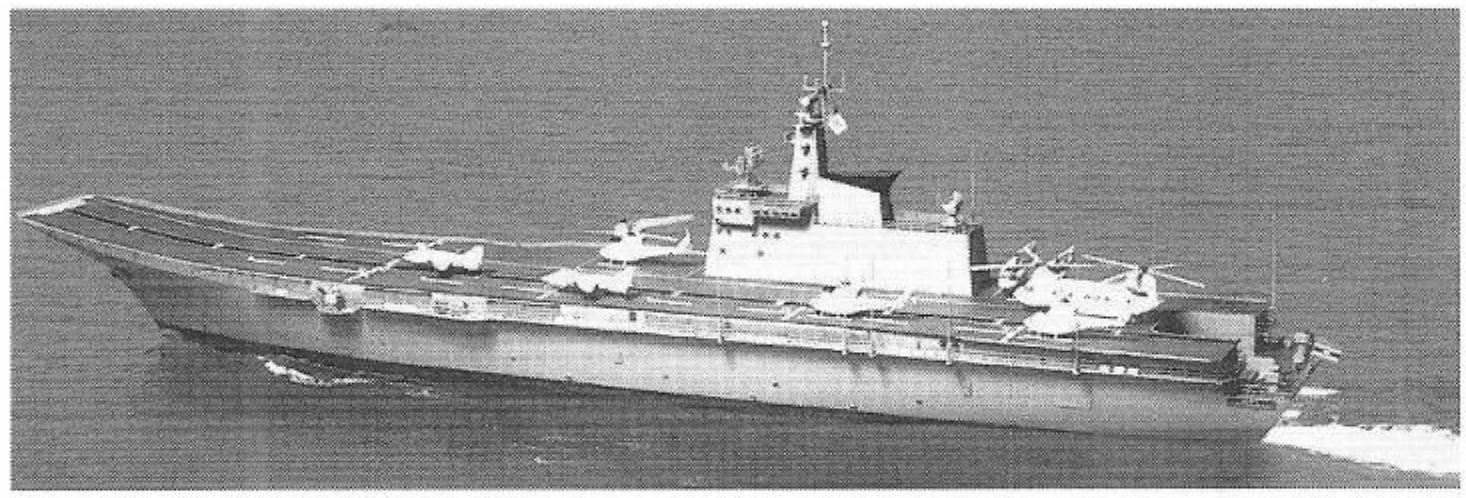
Range: 10,000+ n miles at 12 kts

Complement:
ship's company: 455 (62 officers)
aircrew: 146
Royal family: 4
troops: normal, 450; max, 675

SHIPS

CHAKRI NARUEBET (911)

Builder	Bazán, Ferrol, Spain
Laid down	12 Jul 1994
Launched	20 Jan 1996
Commissioned	27 Mar 1997



Artist's impression of Chakri Naruebet *at sea, with AV-8S Matadors, UH-1Ns and CH-47 Chinooks on the flight deck* (Bazán)

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Mk 41 Vertical Launch System
As built, the ship is fitted for, but not with, vertical launchers for a missile system. The type is as yet unspecified, but will probably be an eight-cell Mk 41 vertical launch system for NATO Sea Sparrow missiles.

GUNS

Close In Weapons System
Similarly, the ship is fitted for, but not with, four CIWS units; two on port and starboard sponsons forward and two on the stern. Should the Thai Navy decide to place an order the contenders would presumably be the US Vulcan Phalanx, Dutch Goalkeeper, and the Spanish Meroka (the last-named, as fitted in *Principe de Asturias*), although it is reported that Vulcan/Phalanx is the preferred system.

ELECTRONIC WARFARE SYSTEMS

DECOYS

Preparatory work has been carried out by the builders for the installation of decoys, such as chaff launchers and torpedo decoys, when the user has decided what is to be fitted. These will probably be provided by the USA under FMS funding and installed in Thailand after delivery.

COMMAND AND CONTROL SYSTEMS

A command and control system has been developed for *Chakri Naruebet* by Bazán under a $79 million contract signed in November 1995. Derived from that installed in the Spanish carrier, *Principe de Asturias,* the Thai system has eight C² Inisel CONAM colour consoles (but with space for a further three), a large screen display and a plotting table. The Spanish Navy's software centre is involved in adapting the software package used in the *Principe de Asturias* for use in the Thai carrier.

Manufacturer/Contractor
FABA Division of Empresa Bazán, Spain.

SONARS

Again, the user has not yet decided whether or not to fit a sonar, but the mountings are available for a hull-mounted, medium-frequency system, similar to that in *Principe de Asturias*.

RADARS

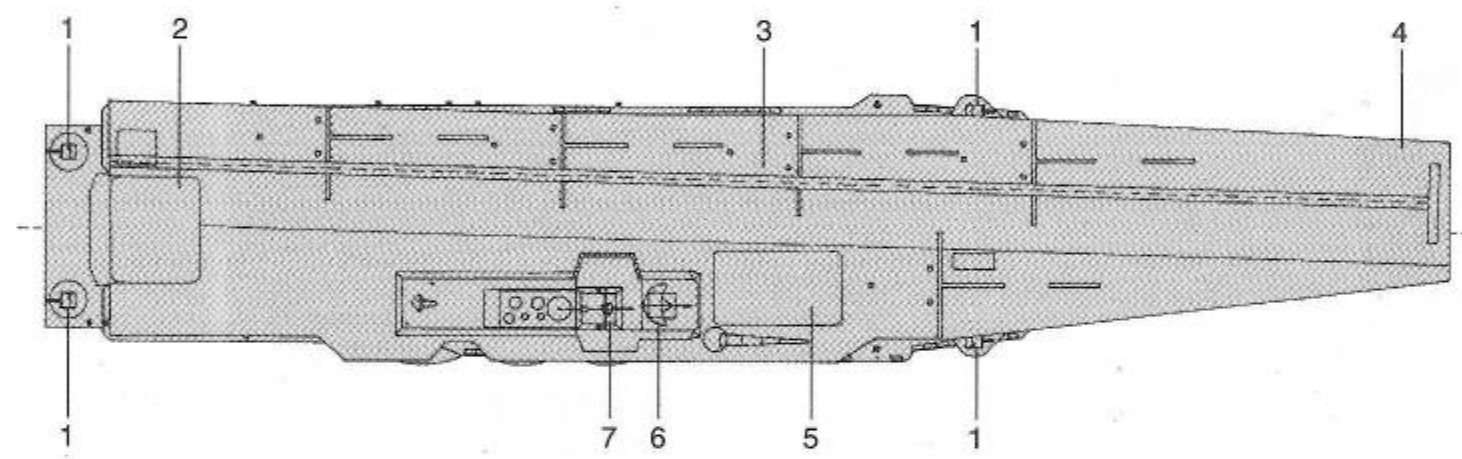
Type	SPS-52C	SPS-64
Maker	Hughes	Raytheon
Role	3D long-range air search	Navigation
Band	E/F	I or F
Beam	1.1 × 2.25°	I-band 1.9 × 22° or 1.25 × 22° or 0.9 × 22° or 0.7 × 22° F-band 2 × 25°
Peak power	1,000 kW	I-band 20 kW or 50 kW F-band 60 kW
Gain	39.5 dB	28 dB
Pulsewidth	2.5/4/6/10 µs	0.06/0.5/1.0 µs
PRF	1,850/925 pps	3,600/1,800/900 pps
Scan rate	15/6 rpm	33 rpm
Typical range	240 n miles (440 km)	

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 174.6 × 27.5 m (572.8 × 90.2 ft)
Ski ramp: 12°
Elevators: 2 (1 forward on starboard side, 1 aft on centreline; 20 t capacity each)

Air wing
In peacetime the air wing will normally consist only of helicopters: usually, four ASW and six troop carriers. In war this would be increased to a maximum of either 15 helicopters or 12 AV-8S Matador V/STOL fighters or an appropriate mix. The hangar can accommodate maximum of 15 Sea King-equivalent helicopters or Harrier VSTOL aircraft, while up to five CH-47 Chinook helicopters can be parked on the deck. There are five landing/take-off spots.

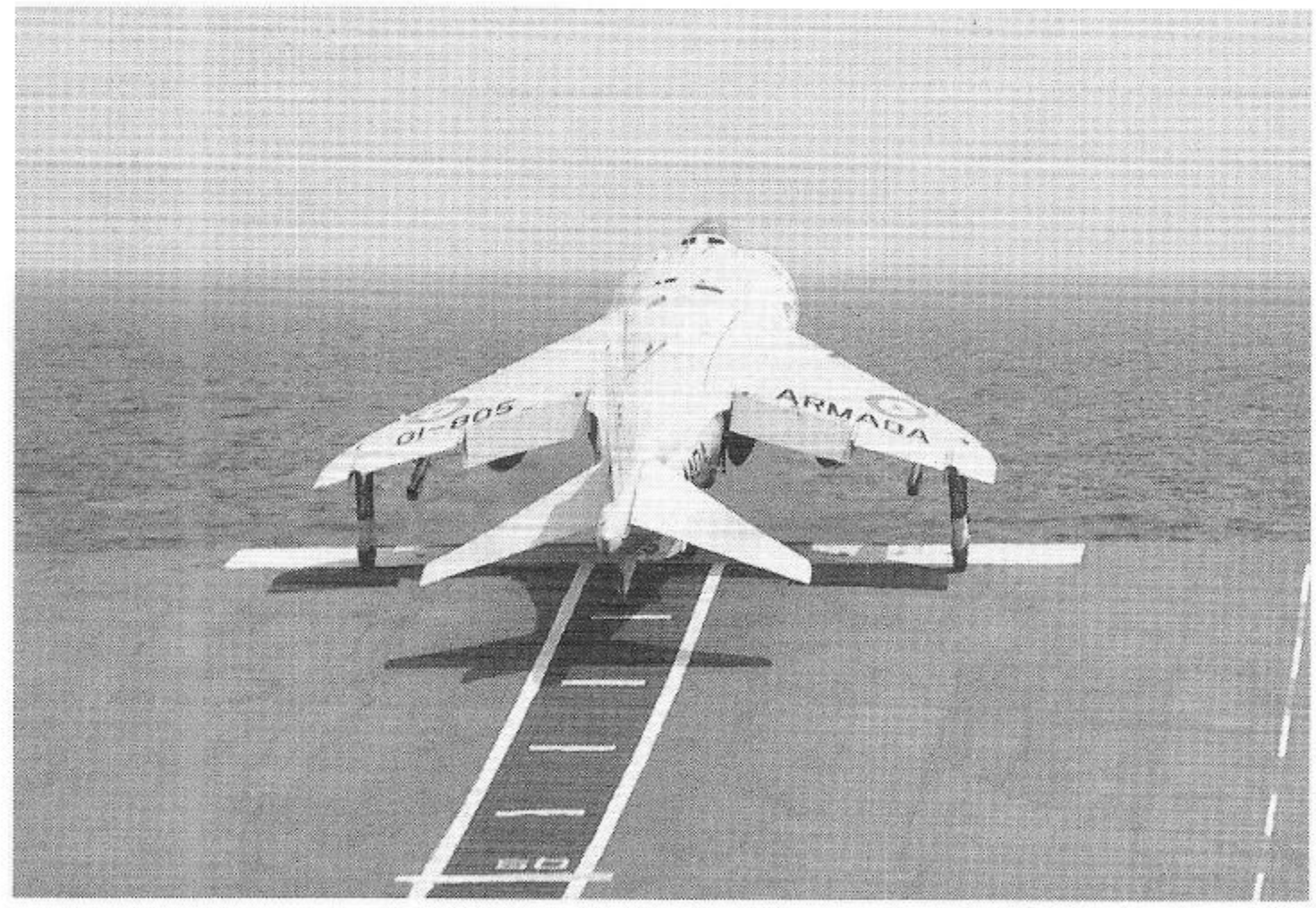


Chakri Naruebet (Ian Sturton)
1 *Site for close in weapons system (type to be decided)* **2** *After centreline elevator; 13.5 × 3.5 m (44.3 × 11.5 ft)* **3** Flight deck; 174.6 × 27.5 m (572.9 × 90.2 ft) **4** *Ski ramp; 12°* **5** *Forward elevator* **6** *Surface search radar array (probably SPS-52C)* **7** *Air/surface search radar array*

FIXED-WING AIRCRAFT

BAe/McDonnell Douglas Harrier VA.1 (AV-8S) Matador
The Royal Thai Navy (RTN) has purchased nine VA.1 Matadors (BAe/McDonnell Douglas AV-8S Harriers) from the Spanish Navy at a cost of $90 million. The contract was signed in 1994 for delivery in 1997.

Specifications
Wing span: 7.70 m (25.25 ft)
Length: 13.87 m (45.50 ft)
Height: 3.63 m (11.92 ft)
Operating weight, empty: 5,529 kg (12,190 lb)
Max take-off weight:
short take-off (STO): 10,115 kg (22,300 lb)
vertical take-off (VTO): 7,734 kg (17,050 lb)
Max fuel: internal 2,295 kg (5,060 lb)
Max weapon load: 2,404 kg (5,300 lb)
Max level speed, low altitude: 635 kts (1,176 km/h)
Attack radius: 360 n miles (667 km)
Engine: 1 Rolls-Royce Pegasus Mk 103 (95.64 kN; 21,500 lb st)
Accommodation: 1 (pilot)
Weapons: 30 mm guns, bombs, rockets and flares



One of nine AV-8S Matadors which will soon be flying in Thai colours and operating from Chakri Naruebet (MoD, Madrid)

PROPULSION

Specifications
System: Combined diesel or gas (CODOG)
Main machinery:
gas turbines: 2 General Electric GE LM-2500
diesels: 2 MTU 16 V 1163 TB 83

Power output:
gas turbines: 2 × 16,500 kW at 3,600 rpm
diesels: 2 × 4,115 kW at 1,600 rpm
Shafts: 2

Propellers: controllable pitch; 4.75 m (15.58 ft); 180 rpm
Electrical power: 4 Bazán-MAN generators

Chakri Naruebet *was launched at Empresa Nacional Bazán's Ferrol shipyard on 20 February 1996. The ship is now being fitted out and will be handed over to the Royal Thai Navy in March 1997* (Joris Janssen Lok)

DAMAGE CONTROL

The ship is divided into three damage control/fire zones and is fitted with seven fire pumps each capable of delivering 225 m^3/h at 10.5 bar.

FURTHER INFORMATION

PROGRAMME

South-east Asia has been an unsettled area for many years and the Royal Thai Navy (RTN) has been following a policy of slow but steady expansion to cope with the naval threat in both the South China Sea and the Indian Ocean. It was, therefore inevitable that its aspirations should turn to seaborne air power and in 1991 a contract was placed with German shipbuilder Bremer Vulcan for a 7,800 tonne helicopter carrier, although this was abruptly cancelled on 22 July of that year. The RTN then looked elsewhere and on 27 March 1992 a government-to-government contract was concluded with Spain for a larger ship to be built by Empresa Bazán at a cost of $360 million. Fabrication started in October 1993 and the later announcement that Harrier aircraft are to be acquired from the Spanish Navy confirmed that this is to be an aircraft rather than a helicopter carrier.

NAME

The ship's name, *Chakri Naruebet*, means 'In honour of the House of Chakri'.

DESIGN

The design is, in general terms, similar to that of the Spanish Navy's own carrier *Principe de Asturias* and incorporates many of the lessons learned by the Spaniards. Like the Spanish carrier, *Chakri Naruebet* has a 12° ski jump and two 20 tonne aircraft lifts, but there will also be a number of major differences.

One of the most apparent external differences (especially when seen from ahead) is that the entire flight deck is offset to port, giving a distinctly asymmetric appearance. Of greater operational significance is that *Chakri Naruebet* has a large, 20.5×7.0 m (67.26×22.96 ft) docking-well aft, which accommodates three 18.5 m (60.7 ft) long landing craft, discharging them through a large stern door. There is also stowage on the flight deck for three LCVPs. A further difference is that, while it has the same power installation, the Thai ship has two propellers rather than one. Finally, to meet Thai national requirements, special accommodation has been constructed for and is permanently reserved for up to four members of the royal family.

Final decisions on weapon systems and a number of sensors have yet to be made and the ships being 'fitted for but not with' items such as the Mk 41 VLS. It is expected that most of this equipment will be purchased from the USA through the FMS system and installed in Thailand after delivery.

Special measures have been taken to ensure that the ship can carry out its primary role of disaster relief. These include provision for the carriage of containers and specialised vehicles in the hangar and on the flight deck, a hospital with overflow facilities in the chief petty officers' mess, and the ability to supply water and electrical power to the shore. A special elevator connects the hangar deck to lower decks and is used for moving casualties down to the hospital and ammunition up from the magazines.

The ship is fitted with two pairs of stabilisers.

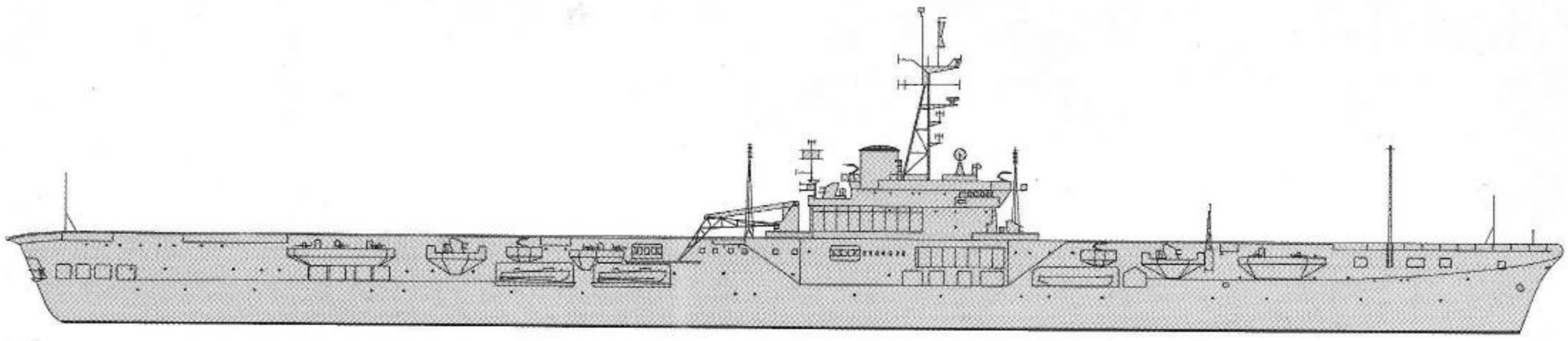
OPERATIONAL

The stated primary missions of the ship are: disaster relief; search and rescue; emergency evacuation; law enforcement at sea; environmental protection; and national interest protection. The secondary missions are stated to be: air support of naval operations; command and control of naval forces; aviation training and qualification; and cadet training. *Chakri Naruebet* will, however, be the first new-build aircraft carrier for any South-east Asian navy, while the RTN will become only the second navy in the South China Sea/Indian Ocean area to possess its own at sea air power. It thus seems inevitable that the secondary missions will eventually become paramount at some time during this interesting ship's career.

AIRCRAFT

The RTN helicopter fleet currently includes eight Bell 212ASW, with a further six Sikorsky S-70B Seahawks ordered in 1993 for delivery in 1997. Despite the builder's statement that the hangar will accommodate 15 'Sea King-equivalent' helicopters, there are no such aircraft in the Thai inventory and this must be taken as simply an internationally understood concept of size rather than an indication of an intention to operate Sea Kings. The CH-47 Chinooks will come from the squadron of eight aircraft operated by the army.

BRITISH LIGHT FLEET CARRIER



British 'Colossus' Class (Ian Sturton)

OVERVIEW

During the Second World War the Royal Navy built six new 'fleet carriers,' typically displacing 29,730 tonnes and carrying 55 aircraft, all of which had been designed before the war. These were reinforced by a number of elderly carriers and some rapidly converted merchant ships, known as 'escort carriers' carrying a few aircraft. Two new designs were accepted in 1942, with the initial ships being laid down soon afterwards. The first was for a new type of 37,000 tonne fleet carrier, capable of operating up to 100 aircraft, which resulted in the *Eagle* and *Ark Royal,* neither of which joined the fleet until well after the war had ended. The second design was for an 'interim,' utility carrier, displacing 18,040 tonnes (full load) and carrying 37 aircraft, which was given a new designation: 'light fleet carrier.'

The design was prepared by Vickers at Barrow, since there was no spare capacity in the relevant Admiralty departments, the main requirements being that the ships should be designed on 'austerity' lines, must be quick to build and only needed to last until either the end of the war or to 1945, whichever was the earlier. To achieve these goals, the required maximum speed was limited to 25 knots; optimum propulsive efficiency was achieved in a narrow 20 to 24 knots bracket; secondary control positions and back-up machinery were eliminated (for example, the lifts had only one set of electrical machinery each); the flight deck was unarmoured; there was no armour protection for the hull; the ships' own armament was restricted to a mix of light air defence weapons; and maximum use was made of existing designs of machinery and equipment. Finally, in view of the ships' short planned life, any design feature intended only for comfort or convenience was ruthlessly eliminated and anti-corrosion measures were kept to the minimum.

The light fleet carrier was designed from the outset as an aircraft carrier and, while mercantile standards were applied to structural strength, the internal sub-divisions were more numerous than would be found in a merchant ship in order to achieve greater survivability. Watertight integrity was ensured by transverse bulkheads and good design, which ensured that a single torpedo hit could, at worst, flood only two adjacent sections.

There were four classes within the 'light fleet carrier' category. The first was the basic 'Colossus' class, of which eight were completed (see table) and one of which, the Brazilian *Minas Gerais* (ex-HMS *Vengeance*), is still in service, while a second, the Argentine *Veinticinco de Mayo* (ex-HMS *Venerable*), is in a long refit. Two of the 'Colossus' class were converted to aircraft repair and maintenance ships during construction and are usually referred to as the 'Perseus' class. Next came the 'Majestic' class, with the same dimensions as the 'Colossus' class, and differing principally in internal arrangements for sailors' accommodation and messing; this and other more minor changes resulted in an increase in displacement of some 500 tonnes. Only two of the 'Majestic' class were completed for the RN, with another three being laid up after launch and later completed for Australia, Canada and India, respectively; the last of these, INS *Vikrant*, remains in front-line service as a V/STOL carrier. The sixth carrier of the 'Majestic' class, *Leviathan,* was also laid up incomplete and subsequently used as a source of replacement machinery for the Dutch *Karel Doorman.*

The ships of the last group, the 'Hermes' class, were somewhat larger, being built to operate heavier aircraft, having a length of 226.8 m (744 ft) and a full load displacement of 27,900 tonnes. Four were eventually completed in the 1950s for service with the RN of which one, the former HMS *Hermes,* remains in service as the Indian INS *Viraat.*

Virtually all the ships of the 'Colossus', 'Majestic' and 'Hermes' classes that entered service were repeatedly modified during their operational lives, as their operators attempted to cope with the ever-increasing weights, size and performance of front-line naval aircraft. The advent of the steam catapult alleviated the problem for a while, as did the angled deck and other inventions, but it proved difficult for them to handle second-generation jet aircraft and impossible to handle the third generation, such as the British Buccaneer, French Super Etendard and American Phantom. They were then limited to operating V/STOL Harrier/Sea Harrier fixed-wing fighters, slower fixed-wing ASW types such as the Breguet Alizé, Fairey Gannet and Grumman Tracker, or helicopters. Their age and this inability to handle the latest aircraft have thus caused them to leave service in increasing numbers.

The light fleet carrier was the outcome of many restrictions and compromises, and was intended to last only for some two to three years. In the event it was one of the most successful British warship designs ever, which formed the backbone of the post-war Fleet Air Arm for two decades after the war, as well as bringing carrierborne aviation within the reach of numerous overseas navies. Indeed, three of them are still in service in 1996/97, with a fourth possibly due to return to service — no mean achievement for a 50-year old 'interim' design with a planned life of less than five years.

GENERAL SPECIFICATIONS

(for 'Colossus' class, as built)

Country: UK
Type: Light Fleet Carrier

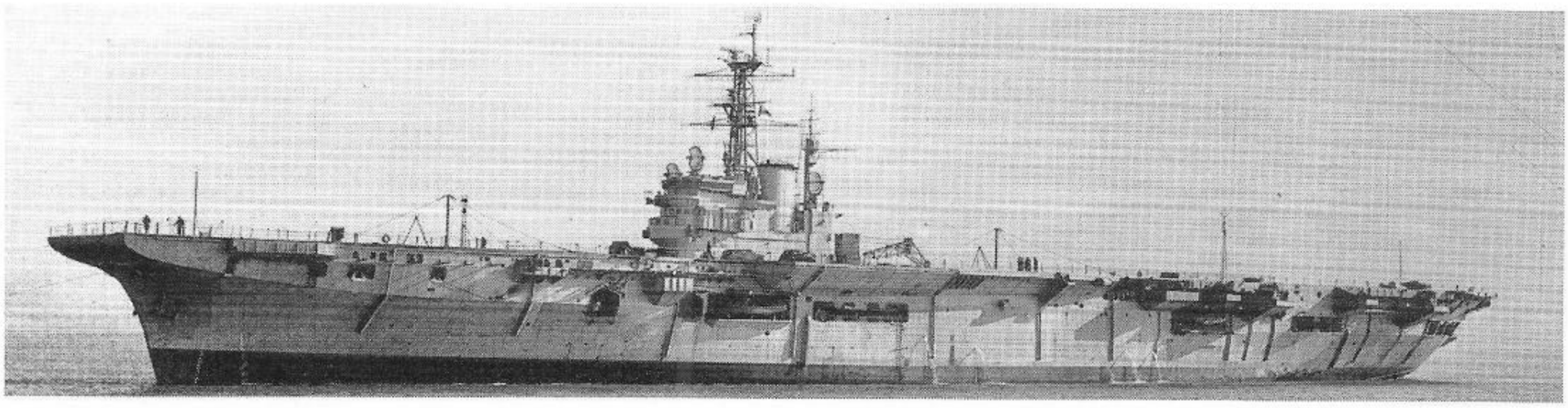
Active: 3 (+1 in long refit)
Built: 17

Displacement:
standard: 13,190 t
full load: 18,040 t
Length: oa 211.3 m (693.2 ft); wl 192 m (630 ft)
Beam: 24.4 m (80 ft)
Draught: 7.11 m (23.4 ft)

Speed: 25 kts
Radius: 7,350 n miles at 20 kts

Complement: *ca* 1,300 incl air crews

SHIPS



British light fleet carrier, HMS Majestic, *in her original state, as built by Vickers, Barrow-in-Furness, UK* (VSEL)

Ship	Builder	Laid down	Launched	Completed	Operational	Disposal
'Colossus' class						
Colossus	Vickers-Armstrong, Tyne	1 Jun 1942	30 Sep 1943	16 Dec 1944	To France (Arromanches); loan — 1946; sold — 1951	Disposal — 1974 Scrapped — 1978
Glory	Harland & Wolff, Belfast	27 Aug 1942	27 Nov 1943	2 Apr 1945	Served RN; reserve — 1956	Scrapped — 1961
Ocean	Stephen & Sons, Glasgow	8 Nov 1942	8 Jul 1944	30 Jun 1945	Served RN; reserve — 1957	Scrapped — 1962
Theseus	Fairfield, Glasgow	6 Jan 1943	6 Jul 1944	9 Jan 1946	Served RN; reserve — 1956	Scrapped — 1962
Triumph	Hawthorn Leslie, Hebburn-on-Tyne	27 Jan 1943	2 Oct 1944	9 May 1946	Served RN; converted to repair ship — 1957-65; reserve 1972	Scrapped — 1981
Venerable	Cammell Laird, Birkenhead	3 Dec 1942	30 Dec 1943	17 Jan 1945	Sold to Netherlands *(Karel Doorman)* — 1948; sold to Argentina *(25 de Mayo)* — 1968	Awaiting refit — 1996
Vengeance	Swan Hunter, Wallsend-on-Tyne	16 Nov 1942	23 Feb 1944	16 Jan 1945	Served RN; lent to Australia - 1952; returned to RN 1955; sold to Brazil *(Minas Gerais)* — 1956	In service — 1996
Warrior	Harland & Wolff, Belfast	12 Dec 1942	20 May 1944	24 Jan 1946	Lent to Canada — 1946; served RN — 1948; sold to Argentina *(Independencia)* — 1958	Scrapped — 1971
'Perseus' class						
Perseus	Vickers-Armstrong, Tyne	1 Jun 1942	26 Mar 1944	19 Oct 1945	Completed as repair ship; served RN — 1946-58	Scrapped — 1958
Pioneer	Vickers-Armstrong, Barrow	2 Dec 1942	20 May 1944	8 Feb 1946	Completed as repair ship; served RN — 1946-54	Scrapped — 1954
'Majestic' class						
Hercules	Vickers-Armstrong, Tyne	14 Oct 1943	22 Sep 1945	4 Mar 1961	Laid up incomplete; sold to India *(Vikrant)* — 1961	In service 1996
Leviathan	Swan Hunter, Wallsend-on-Tyne	19 Oct 1943	6 Jun 1945	—	Laid-up incomplete — 1946; cannibalised for spares	Scrapped — 1968
Magnificent	Harland & Wolff, Belfast	29 Jul 1943	16 Nov 1944	21 May 1948	Lent to Canada — 1946-57; returned to UK, in reserve — 1957-65	Scrapped — 1965
Majestic	Vickers-Armstrong, Barrow	15 Apr 1943	28 Feb 1945	8 Nov 1955	Laid-up incomplete — 1945; sold to Australia *(Melbourne)* — 1955; in reserve — 1982	Scrapped — 1983
Powerful	Harland & Wolff, Belfast	27 Nov 1943	27 Feb 1945	17 Jan 1957	Laid-up incomplete — 1945; sold to Canada *(Bonaventure)* — 1952; in reserve — 1970	Scrapped — 1970
Terrible	HM Dockyard, Devonport	19 Apr 1943	30 Sep 1944	5 Feb 1949	Laid-up incomplete — 1945; sold to Australia *(Sydney)* — 1948, in reserve — 1973	Scrapped — 1975
'Hermes' class						
Albion	Swan Hunter, Wallsend-on-Tyne	23 Mar 1944	6 May 1947	26 May 1954	Served RN	Scrapped — 1973
Bulwark	Harland & Wolff, Belfast	10 May 1945	22 Jun 1948	4 Nov 1954	Served RN — 1954-81; in reserve 1981	Scrapped — 1984
Centaur	Harland & Wolff, Belfast	30 May 1944	22 Apr 1947	1 Sep 1953	Served RN — 1953-66; in reserve — 1966	Scrapped — 1972
Hermes (ex-*Elephant*)	Vickers-Armstrong, Barrow	21 Jun 1944	16 Feb 1953	18 Nov 1959	Served RN — 1959-84; in reserve — 1984; sold to India *(Viraat)* — 1986	In service — 1996

WEAPONS SYSTEMS

GUNS

2 pounder (2 pdr)

2 pdr 'pom-pom.' The numbers and types of guns varied widely between ships and according to the theatre of operations. 'As built' the 'Colossus' class was armed with a mix of quad and single Vickers 40 mm (1.575 in) recoil-operated, water-cooled guns. The gun was universally known as the 'pom-pom' from the noise of its firing and although the original shell weighed 2 lb (907 g), the designation was not changed when a new, lighter, but much faster shell was introduced. There were six quad mounts in *Colossus, Venerable, Vengeance* and *Glory;* and six quad plus seven single mounts in *Ocean*.

Specifications

Calibre: 40 mm (1.575 in)
Shell: 764 g (1.684 lb)
Muzzle velocity: 732 m/s (2,400 ft/s)

40 mm Bofors

Colossus, Venerable, Vengeance mounted 21—40 mm Bofors, while *Ocean* had 12.

Specifications

Calibre: 40 mm
Bore: 56.25 calibres
Shell: 900 g (1.985 lb)
Muzzle velocity: 881 m/s (2,890 ft/s)
Operation: Recoil
Cooling:
air: Single mount
water: twin/quad mounts
Rate of fire: 120 rpm/barrel

COMMAND AND CONTROL SYSTEMS

RADARS

Type 277

One Type 277 surface search and height-finder radar.

Specifications
Band: S
Beam: 4.5 × 2.2°
Peak power: 500 kW
Pulsewidth: 0.7/1.5/1.9 µs
Pulse repetition frequency: 500 pps
Scan rate: 7.5 rpm
Typical range: detection — aircaft at 1,500-6,000 m (5,000-20,000 ft) — 55 n miles

Type 293

One Type 293 short-range and air traffic control radar.

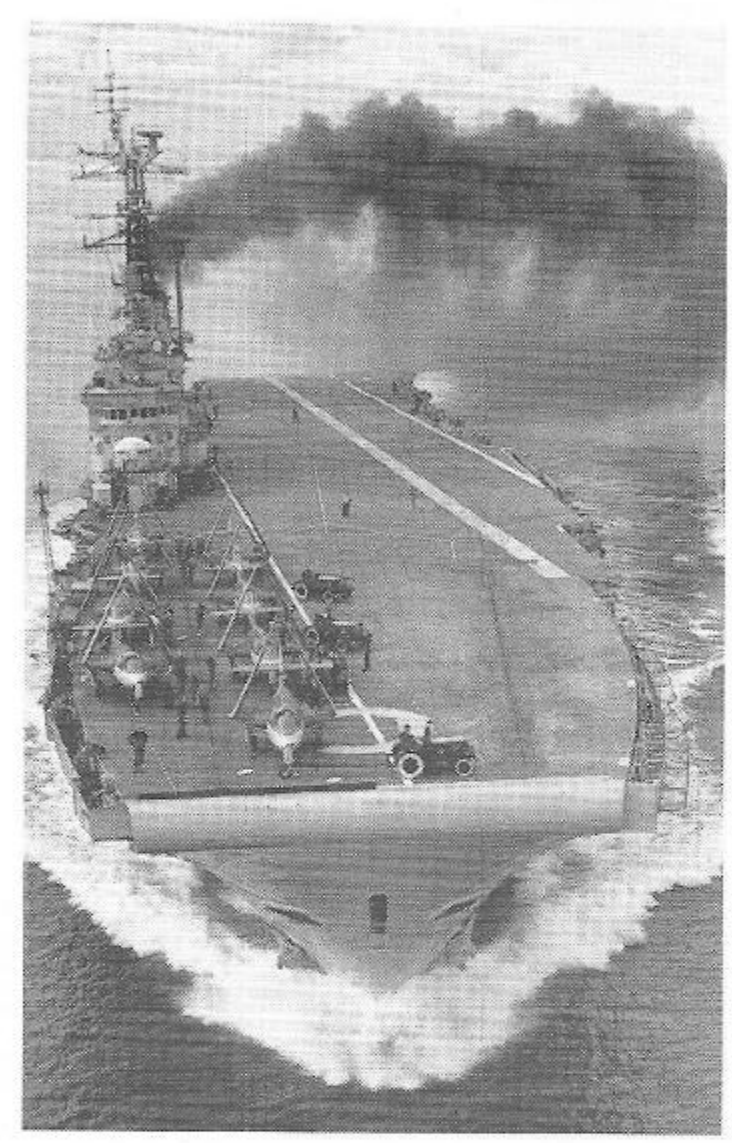
Specifications
Band: S
Beam: 2 × 35°
Peak power: 500 kW
Pulsewidth: 0.7/1.5/1.9 µs
Pulse repetition frequency: 500 pps
Scan rate: 5,10 or 15 rpm
Typical range: 30-35 n miles

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 210 × 24.4 m (690 × 80 ft)
Hangar: 135.6 × 15.8 × 5.3 m (445 × 52 × 17.5 ft)
Elevators: Two centreline — 13.7 × 10.4 m (45 × 34 ft); 6,804 kg (15,000 lb) capacity
Catapult: 1 BH III twin track, hydraulic
Arrester wires: 8
Aviation fuel: 448,230 litres (118,400 US gallons)

The British light fleet carriers brought naval aviation to many smaller navies in the post-war years. This is HMAS Melbourne, *formerly HMS* Majestic, *with an air wing comprising A-4 Skyhawk strike aircraft, S-2 Tracker long-range ASW aircraft and Westland Wessex helicopters* (RAN)

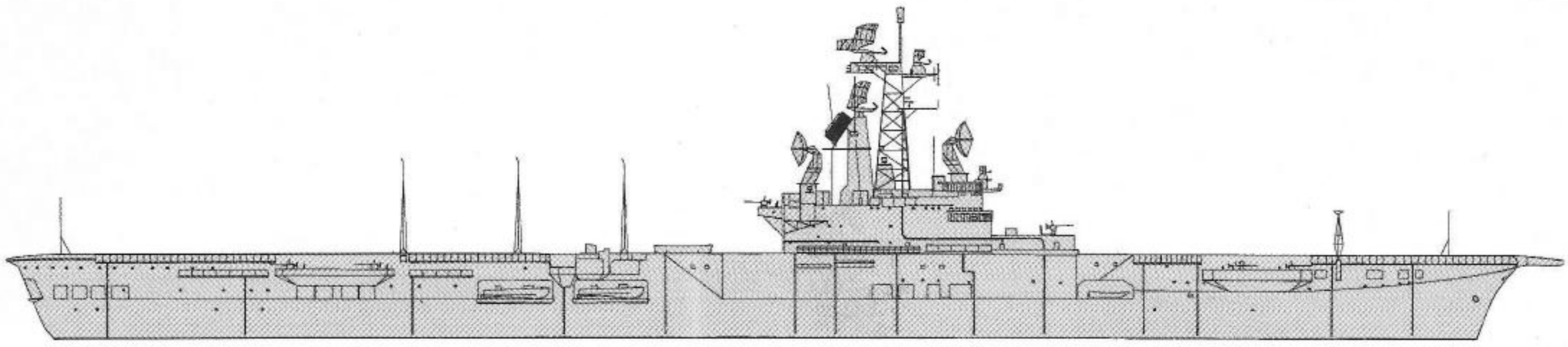


HMS Centaur, *showing a typical early 1950s flight deck scene, with a 5° 'interim' angled deck and eight Hawker Seahawk strike fighters* (Jane's)

PROPULSION

Specifications
Type: Steam
Boilers: 4 Admiralty pattern
Working pressure: 28.1 kg/cm² (400 psi)
Operating temperature: 371°C (700°F)
Turbines: 2 sets Parsons geared turbines
Power output: 30 MW (40,000 hp)
Shafts: 2

VEINTICINCO DE MAYO



Veinticinco de Mayo (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Argentina
Type: British light fleet carrier (CV)

Class: COLOSSUS

Active: 0
Refit: 1

Displacement:
standard: 15,892 t
full load: 19,896 t
Length: oa 211.3 m (693.2 ft); wl 192 m (630 ft)
Beam: 24.4 m (80 ft)
Draught: 7.6 m (25 ft)

Speed: 24 kts

Complement: 1000 plus up to 500 aircrew

SHIPS

VEINTICINCO DE MAYO (V 2)

Builder	Cammel Laird, Birkenhead, UK
Laid down	3 Dec 1942
Launched	30 Dec 1943
Commissioned	17 Jan 1945 (RN) (HMS *Venerable*)
Sold	1948 (Netherlands) (Hr Ms *Karel Doorman*)
	15 Oct 1968 (Argentina)
Commissioned	12 Mar 1969 (ARA *Veinticinco de Mayo*)

WEAPONS SYSTEMS

GUNS

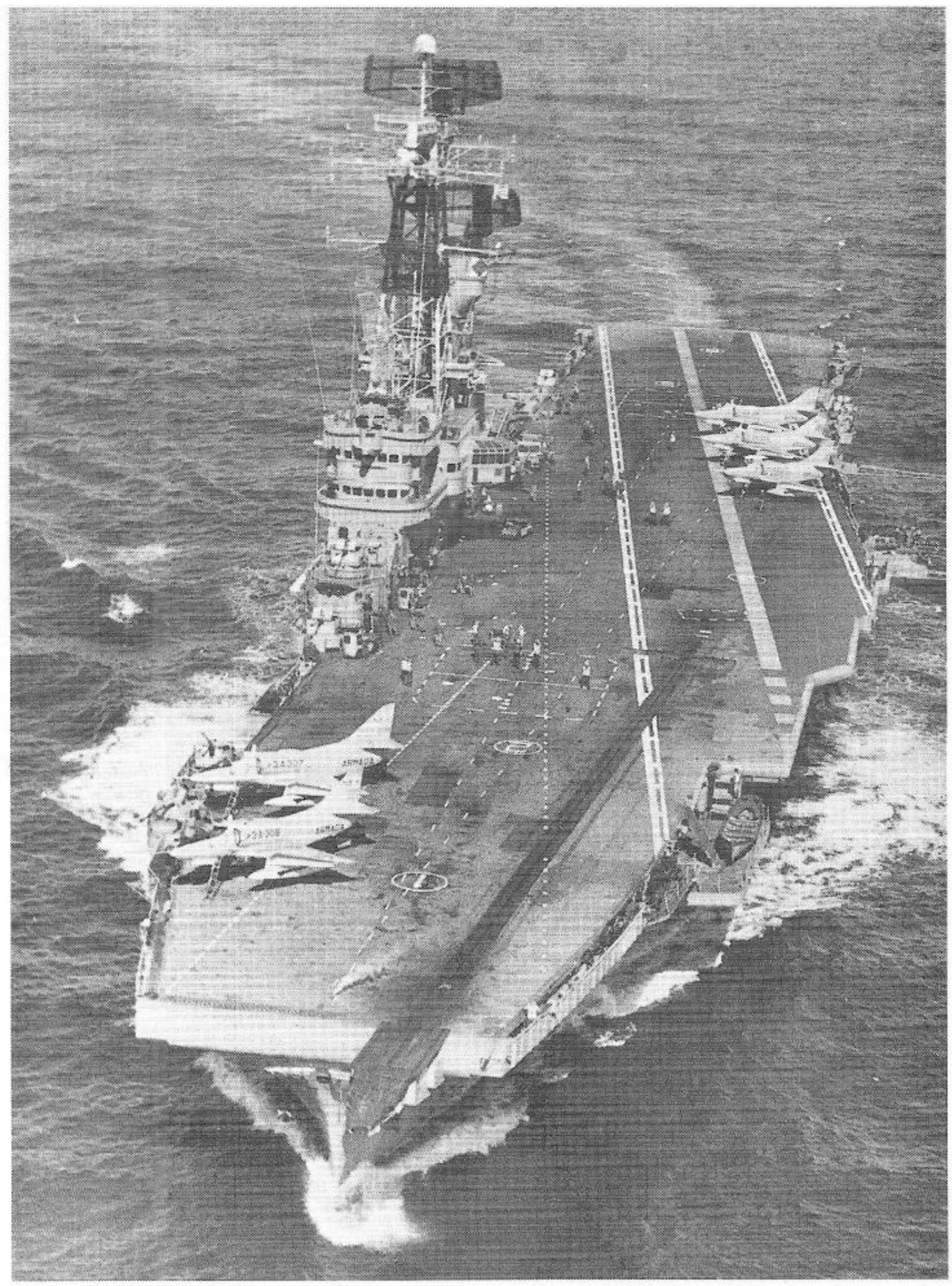
Bofors SAK 40L/70
9 Bofors SAK 40L/70 in single mounts.

Specifications
Traverse: 360° (nominal)
Training speed: 90°/s
Elevation: −3 to +85°
Elevation speed: 60°/s
Rate of fire: 300 rds/min
Muzzle velocity: 1,005-1,025 m/s (3,297-3,363 ft/s)
Max range:
anti-surface: 6.5 n miles (12 km)
anti-air: 2.2 n miles (4,000 m)
Ammunition weight: 2.4 kg (5.29 lb)
Projectile weight: 0.96 kg (2.12 lb)
Power: 440 V, 3-phase 60 Hz
Crew: 4

COMBAT DATA SYSTEMS

SEWACO
Veinticinco de Mayo is fitted with the Dutch SEWACO (SEnsor Weapon control And COmmand) system. At the heart of this system is the DAISY (Digital Action Information SYstem) C^2 which integrates the various radars and presents raw and/or processed sensor data from search and fire-control radars together with IFF, sonar, electronic warfare and electro-optic systems to create a picture of the tactical situation. This data is provided by onboard or offboard sensors through a Link 11 tactical datalink.

Manufacturer/Contractor
Hollandse Signaalapparaten, Netherlands.

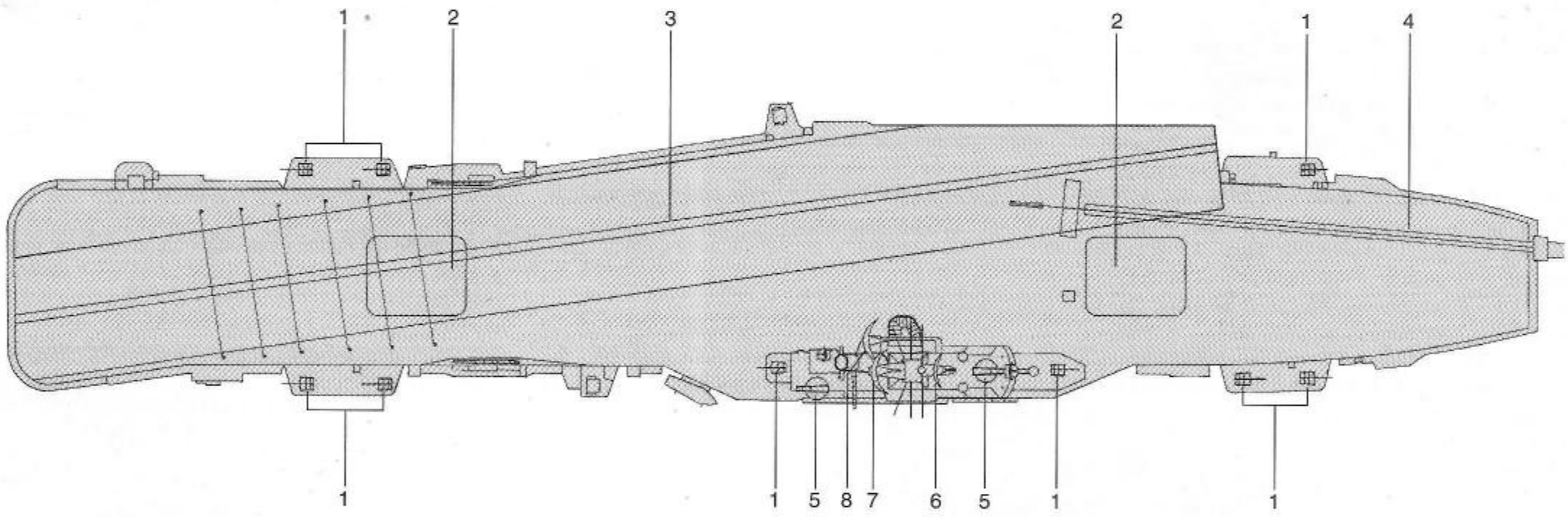


Veinticinco de Mayo *at sea, showing the very limited deck space on these elderly carriers* (Argentine Navy)

RADARS

Type	LW-08	DA-08	V1-01 (SGR-109)	ZW-01 (SGR-103)	TM 1226	SPN-720
Maker	Signaal	Signaal	Signaal	Signaal	Decca	SMA
Role	Air search	Surface/air search	Height-finder	Surface/low-altitude search	Surface search	Carrier-controlled approach (CCA)
Band	D	F	D/E	I/J	I	I/J
Beam	2.2 × csc² to 40°	1.5 × csc² to 40°	3.5 × 1.2°	1.0 × 3.5°	1.2°	n/a
Peak Power Average	150 kW, pulse compressed; 5.2 kW	145 kW 5.1 kW	500 kW	180 kW	25 kW	180 kW
Gain	30 dB	33 dB	39 dB	39 dB	30 dB	n/a
Pulsewidth	35/90 µs	35/69 µs	1.5/0.5 µs	0.1/0.3 µs	0.05/0.25/1.0 µs	n/a
PRF	1,000/500 pps	1,000/500 pps	500/1,000 pps	2,000/1,000 pps	n/a	n/a
Scan rate	7.5/15 rpm	10/20 rpm	50/20 scans/min	7.5/15 rpm	28 rpm	n/a
Typical range	145 n miles at 26,000 m (85,306 ft) for 2 m² target	78-92 n miles for 2 m² target Min 0.8 n miles	150 n miles with coverage up to 37,000 m (121,397 ft)	Fighter (1-3 m²) — 30 n miles Bomber (10-40 m²) — 48 n miles Small surface vessels — 18 n miles Periscopes — 4.5 n miles	n/a	Search: 2,000 m altitude at 15 n miles Approach: 8 n miles at +21 to −2° to horizontal plane

AVIATION



Veinticinco De Mayo (Ian Sturton)
1 *Bofors SAK 40 mm L70* **2** *Elevator 13.7 × 10.4 m* **3** *Angled flight deck; 8.5°; 212.6 × 40.6 m (697.7 × 133.4 ft)* **4** *Steam catapult* **5** *V1-01 height-finding radar* **6** *TM 1226 navigation radar* **7** *LW-08 air search radar* **8** *DA-08 surface/air search*

AVIATION FACILITIES

Specifications
Flight deck: 212.6 × 40.6 m (697.7 × 133.4 ft)
Hangar: 1 hangar, total size, 138.7 × 15.8 × 5.3 m (455 × 52 × 17.5 ft)
Elevators: 2 centreline

FIXED-WING AIRCRAFT

Grumman S-2E/G Tracker

Six S-2E/G Trackers. The Argentine Navy has operated seven Grumman S-2E Trackers for some years, with an additional three S-2Gs acquired from the USA in 1994. Six of the S-2Es have recently been upgraded to Grumman S-2UP standard, which is identical with the S-2F3T Turbo-Tracker standard, developed by Marsh Aviation in the USA, although the conversion work in this case was actually carried out by IAI's Bedek Aviation group in Israel. The work included fitting Garret TPE-331-15 AW turboprops, five-bladed propellers, improved air conditioning and oxygen systems, a wing-mounted searchlight, together with a new autopilot and other modern flight systems. It is assumed that the one remaining unconverted S-2E, together with the three newly acquired S-2Gs will be similarly converted when funds are available. In the absence of *Veinticinco de Mayo,* deck-landing and take-off skills for these aircraft are kept alive by annual exercises aboard USN carriers.

Specifications
IAI (Marsh/Northrop Grumman) S-2UP Tracker multiplace ASW aircraft
Wing span: 22.12 m (72.58 ft)
Width (wings folded): 8.33 m (27.33 ft)
Length overall: 13.26 m (43.5 ft)
Height overall: 5.06 m (16.58 ft)
Wheel track: 5.63 m (18.5 ft)
Wing area: 46.08 m² (496 sq ft)
Weight, empty: 6,282 kg (13,840 lb)
Max payload: 6,881 kg (15,160 lb)
Max take-off weight: 13,163 kg (29,000 lb)
Max speed at S/L: 260 kts (481 km/h)
Max speed at altitude: 296 kts (548 km/h)
Range, no reserve: 647 n miles (1,200 km)
Engines: 2 Garrett TPE331-15AW turboprops, each with 1 Hartzell five-bladed reversing propeller.
Accommodation: 4 (pilot, co-pilot, radar operator, MAD operator)
Sensors: APN-122 Doppler radar; APN-117 low-altitude radar altimeter; AQA-3 Jezebel acoustic search equipment using sonobuoys; sniffer passive submarine exhaust detector; Julie active acoustic echo ranging; ASQ-10 MAD; retractable 75 kW X-band search radar antenna; underwing searchlight
Weapons: Weapons bay — homing torpedoes (2), or Mk 101 depth bomb (1), or 175 kg (385 lb) depth charges (4). Underwing pylons (6) — torpedoes; 127 mm (5 in) rockets; Zuni rockets; 113 kg (250 lb) bombs

HELICOPTERS

Sikorsky SH-3D/H Sea King

Four SH-3D/H Sea King anti-submarine warfare helicopters.

Specifications
Main rotor diameter: 18.90 m (62.0 ft)
Length overall (both rotors turning): 21.91 m (71.89 ft)
Fuselage length: 16.69 m (54.75 ft)
Height to rotor head: 4.74 m (15.5 ft)
Rotor disc area: 280.5 m² (3,019 sq ft)
Max take-off weight: 9,525 kg (21,000 lb)
Internal cargo capacity: 2,720 kg (6,000 lb)
Max speed (never exceed): 144 kts (267 km/h)
Typical cruising speed: 120 kts (222 km/h)
Service ceiling: 3,720 m (12,200 ft)
Range with max standard fuel: 630 n miles (1,166 km)
Engines: 2—1,118 kW (1,500 shp) General Electric T58-GE-100 turboshafts
Role equipment: Underwing pylons (6), torpedo bay, sonobuoy ports (32), depth charge racks (2), search radar, FLIR, MAD
Accommodation: 4 (pilot, co-pilot, 2 sonar operators)
Sensors: Low-frequency 360° AQS-18/AQS-13F sonar; Doppler radar; SMA/APS-707 radar (chin radome)
Weapons: Homing torpedoes (A 224AS, Mk 44 or Mk 46) (2 or 4); or depth charges (4), or Exocet AM39 anti-ship missiles (2)

Aerospatiale A 103 Alouette III
One Aerospatiale A 103 Alouette III, general purpose, search and rescue, light helicopter.

Specifications
Main rotor diameter: 11.02 m (36.15 ft)
Length overall (rotor turning): 12.84 m (42.15 ft)
Fuselage length: 10.17 m (33.7 ft)
Height to rotor head: 3.00 m (9.84 ft)
Weight, empty: 1,143 kg (2,520 lb)
Max take-off weight: 2,200 kg (4,850 lb)
Max speed (never exceed): 113 kts (210 km/h)
Max cruising speed: 100 kts (185 km/h)
Service ceiling: 3,200 m (10,500 ft)
Range with max standard fuel: 267 n miles (495 km)
Engines: 1–694 kW (870 shp) Turbomeca Artouste IIIB turboshaft derated to 425 kW (570 shp)
Accommodation: 7 (pilot plus 6)
Weapons: Various weapons can be carried, incl 1–7.62 mm AA52 MG, or 1–20 mm MG 151/20 cannon, or 4 AS 11 or 2 AS 12 missiles

PROPULSION

Originally, *Veinticinco de Mayo* had the standard British Admiralty-pattern propulsion machinery (see 'Propulsion' under 'Light Fleet Carrier'). The original boilers were replaced by those from the uncomplete *Leviathan* in 1965-66, followed by turbines from the same source in 1968. Since the ship was put into refit in mid-1980s a number of alternative main engine plans have been considered, including a COSAG system, which would have involved new boilers plus gas-turbine boost engines, and CODOG, with four Sulzer diesels and gas-turbine boost. A contract was then placed with Italian company, Fincantieri, in June 1990 for technical assistance to AFNE, Santiago, by which time the proposed propulsion plan was to replace the Parsons steam turbines with General Electric/Fiat Aviazione LM 2500 gas turbines, and to install variable-pitch (vp) propellers, and a DMD power-generation system. By late 1994 the old engines had been stripped out and by then a new CODOG propulsion system was being discussed. Work continues but at a very slow pace.

FURTHER INFORMATION

PROGRAMME

One of the ten-strong 'Colossus' class, *Veinticinco de Mayo* served with the Royal Navy as HMS *Venerable* from 1945-48. It was then sold to the Royal Netherlands Navy (1 April 1948) and was given a substantial rebuild and complete modernisation between 1955 and 1958, which included all modern carrier equipment, such as an angled deck, together with fitting a tripod radar mast and tall raked funnel, both of which remain distinguishing marks of the ship to this day. A second, shorter modernisation in 1965-66 included installing boilers from her sister ship, HMS *Leviathan,* which was lying uncompleted in a British yard. During the early part of its Dutch service (1948-55), *Karel Doorman* operated propeller-driven Hawker Sea Fury fighters and Fairey Firefly ASW aircraft, but these were replaced after the 1955-58 refit by Hawker Sea Hawk turbojet fighters and twin-engined Grumman Avenger ASW aircraft. In the early 1960s these were, in their turn, replaced by Grumman S2F1 Tracker aircraft and Sikorsky HSS-1 (SH-34G) Seabat helicopters.

In the mid-1960s, however, the Dutch Navy decided that an aircraft carrier and the associated air wing were no longer affordable propositions. The ship was, therefore, sold to Argentina on 15 October 1968 and refitted at Rotterdam by N V Dok en Werf Mij Wilton-Fijenoord. This included fitting new turbines, which, like the boilers, were taken from HMS *Leviathan.* The ship was commissioned into the Argentine Navy on 12 March 1969 as *Veinticinco de Mayo* (25th of May) and, having completed her refit on 22 August 1969, sailed for Argentina on 3 September, where she replaced the carrier *Independencia* (ex-HMS *Warrior*), another former British light fleet carrier.

OPERATIONAL

In Argentine service *Vienticinco de Mayo* originally operated an air wing of Grumman Tracker ASW aircraft and Douglas A-4Q Skyhawk fighters, with the latter due to be replaced by French-supplied Super Etendard attack aircraft in the early 1980s. The ship was the major element in the Argentine Navy's surface attack force during the 1982 Falklands (Malvinas) War, but still operating Skyhawks, and was the major threat to the British task force when it first arrived in the war zone, until the counter-threat posed by the British nuclear submarines operating in the area forced the task group back into port.

The ship has not been fully operational since 1985 and has been moored at the Puerto Belgrano Naval Base since 1993. As far as is known, no firm decision to scrap the ship has yet been taken and the recent return to service of the Brazilian carrier, *Minas Gerais,* may spur the Argentine Government and navy into restarting work on *Veinticinco de Mayo.*

MODERNISATION

In 1980-81 all necessary modifications, including lengthening and strengthening the catapult, were made to allow for operation of Super Etendards, although, in the event, it has proved difficult to operate these high-performance aircraft from such a small carrier. The area of the flight deck was increased to enable two extra aircraft to use the deck-park and the steam catapult upgraded (it was, in fact, at the makers in Scotland being refurbished at the time of the war). In 1983, following the Falklands (Malvinas) war, the Plessey CAAIS, which had been fitted to achieve compatibility with the 'Hercules' class (Type 42) destroyers, was replaced by a SEWACO system, which is compatible with the 'Almirante Brown' (Meko 360) class destroyers, which were entering service at that time.

It was planned that a major refit would start in 1988, which was to include modifications to the main engines, flight deck, electrical systems, NBCD arrangements and the bridge, as well as the repair of flight deck and lifts, modernisation of the C^{4}I system and a new steam plant for the catapult.

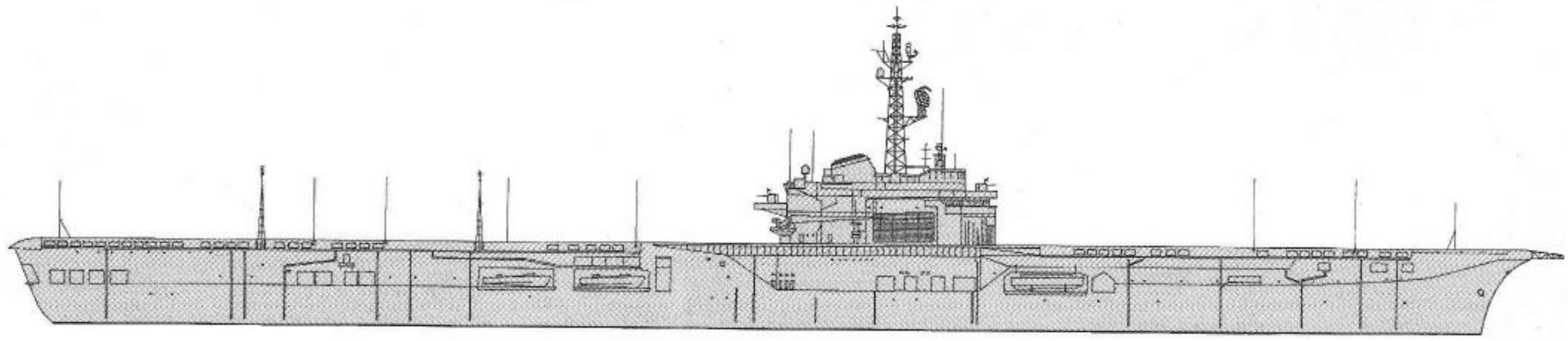
SHIPBOARD AIRCRAFT

For many years the Argentine Navy operated McDonnell Douglas A-4Q Skyhawks from *Veinticinco de Mayo*. 16 of these, essentially revised A-4Bs, were supplied, but the last has now been retired and the the A-4M Skyhawks recently acquired by Argentina from the USA are for the air force, rather than the navy.

Fourteen Dassault Super Etendards were ordered from France in 1980, of which 11 currently remain in the Argentine Navy's inventory, eight in service and three in reserve. These were intended for operation from *Veinticinco de Mayo* and the first five had just arrived when the 1982 Falklands (Malvinas) war broke out. As a result they carried out all their combat operations from land bases and it was not until after the conflict had ended that they were able to carry out carrier classification. These proved the aircraft to be incompatible with the Argentine carrier and it seems improbable that the money could be found to bring the ship up to a standard where such high-performance aircraft could be operated. Thus, if the carrier does return to sea it could only be in the ASW role, operating a mix of fixed-wing aircraft and helicopters, as is the case with the only other South American carrier, Brazil's *Minas Gerais*.

There are four Agusta-Sikorsky ASH-3H Sea King helicopters, with a primary ASW role, although the radar has some surface search capability. There are also five Aerospatiale SA 319B Alouette III light helicopters, with combined ASW/liaison roles, which normally operate from the destroyers, although one is usually included in the *Veinticinco de Mayo's* air wing.

MINAS GERAIS



Minas Gerais (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Brazil
Type: British light fleet carrier (CL)

Class: COLOSSUS

Active: 1

Displacement:
standard: 15,890 t
normal: 17,500 t
full load: 19,890 t
Length: oa 211.8 m (695 ft) (excluding catapult spur)
Beam: 24.4 m (80 ft)
Draught: 7.5 m (24.5 ft)

Speed: 24 kts

Range: 12,000 n miles at 14 kts; 6,200 n miles at 23 kts

Complement: 1,300 (300 aircrew)

SHIPS

MINAS GERAIS (A 11)

Builder	Swan Hunter, Wallsend-on-Tyne, UK
Laid down	16 Nov 1942
Launched	23 Feb 1944
Commissioned	15 Jan 1945 (RN) (HMS *Vengeance*)
Loaned	Aug 1953 (Australia)
Returned	1955 (UK)
Sold	14 Dec 1956 (Brazil)
Commissioned	6 Dec 1960 (Brazil) N Ae L *Minas Gerais*

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Matra SADRAL

Two twin launchers for Matra Sadral *(Système d'Auto Défense Raprochée Anti-aérienne Légère)* point-defence missile systems. The missile is the Mistral.

Specifications
Guidance: IR homing
Range: 2.2 n miles (4 km)
Warhead: 3 kg (1,500 tungsten balls)
Role: Anti-seaskimmer, able to engage targets down to 3 m (10 ft) above sea level

Manfacturer/Contractor
Matra Défense, France.

GUNS

Bofors 40 mm/56

Fitted for, but not with, 10 Bofors 40 mm/56 (2 quad Mk 2, 1 twin Mk 1) light anti-aircraft guns.

Specifications
Traverse: 360° (nominal)
Training speed: 90°/s
Elevation: −3 to +85°
Elevation speed: 60°/s
Rate of fire: 300 rds/min
Muzzle velocity: 1,005-1,025 m/s (3,297-3,363 ft/s)
Max range:
anti-surface: 6.5 n miles (12 km)
anti-air: 2.2 n miles (4,000 m)
Ammunition weight: 2.4 kg (5.29 lb)
Projectile weight: 0.96 kg (2.11 lb)
Power: 440 V, 3-phase 60 Hz.
Crew: 4

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

SRD-19

SRD-19 is an intercept receiver system, using some 24 deck-edge, electronically switched antennas for LF/MF/HF reception, and an Adcock-type array on the mainmast for VHF reception.

Manufacturer/Contractor
Lockheed/Sanders, Nashua, New Hampshire, USA.

ELECTRONIC COUNTERMEASURES (ECM)

GEC-Marconi Shield

Shield is a microprocessor-controlled, fully automatic missile decoy system. Shield selects the most appropriate response from up to six million scenarios held in its EPROM memory, using data obtained from onboard sensors and then automatically deploys the pattern of decoys that will give the highest probability of success. Marconi chaff rockets are fitted with a variable fuze which disperses the chaff at optimum positions along the trajectory. To counter dual-mode threats, both chaff and infra-red decoys can be deployed automatically.

Shield has four protection modes: confusion; distraction; seduction/breaklock: and seduction dump (centroid seduction). The command module is situated in the operations room within easy reach of the EW operator, to enable control in the manual mode and routine monitoring of the system, with manual control from the bridge available as an option.

Specifications
Number of systems: 2—6-tube launchers
Chaff rocket range: 35-2,000 m (38-2,187 yd)
IR decoy range: 40-160 m (131-525 ft)
Rocket diameter: 102 mm (4 in)

Manufacturer/Contractor
GEC-Marconi Naval Systems, Addlestone, UK.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

SICONTA

The SICONTA (SIstema CONtrole TAtico) based upon commercial off-the-shelf hardware, was developed specifically for *Minas Gerais* by the Brazilian Navy's Instituto de Pesquisas da Marinha (IPqM) and was installed in the early 1990s, becoming operational when the carrier recommissioned in 1994. SICONTA is a modular system of tactical data handling systems designed to provide the command team with facilities for tactical picture compilation (air, surface and underwater), threat evaluation and tactical response. Features include automatic target tracking, multisensor picture compilation, datalink control, tactical manoeuvring advice, target designation, EW control, navigational aid and aircraft control. The system is based upon Motorola 68030 and 68040 microprocessors with RS-422 links to the sensors and Ethernet standard links to the consoles, but with a separate radar distributor subsystem. There are intelligent datalink and radar extractor subsystems with 1 Mbyte RAM based upon Intel 8086 microprocessors with Intel 8087 co-processors. The 32-bit computer is controlled by a VRTX (Versatile Real-Time Executive) 32 and system language is C. Interfaces were designed and developed by IPqM and feature the lower-level language assembly, while sensor control software is written in Pascal. Intelligent consoles have been developed by EMGEPRON using Motorola 68020 and 68030 microprocessors and SICONTA can accommodate up to eight of them.

Manufacturer/Contractor
Instituto de Pesquisas da Marinha (IPqM), Brazil.

COMMUNICATIONS AND DATALINKS

Minas Gerais carries the normal ramge of HF, VHF and UHF communications systems for ship-to-ship, ship-to-air and ship-to-shore links. A datalink to provide data exchange between the carrier and 'Niteroi' class frigates has been installed. There is also a Satcom link.

WEAPONS CONTROL

Mk 52 Mod 2 GFCS

There is one Mk 52 Mod 2 GFCS (Gun Fire-Control System) for use in controlling one group of 40 mm Bofors guns. The system is based on the Mk 51 GFCS and includes a Mk 26 range-only radar.

Specifications
Lead angle: 20°
Target speed: 350 kts
Max range:
surface targets: 10,970 m (35,992.6 ft)
airborne targets: 6,400 m (20,998.4 ft)

Mk 63 GFCS

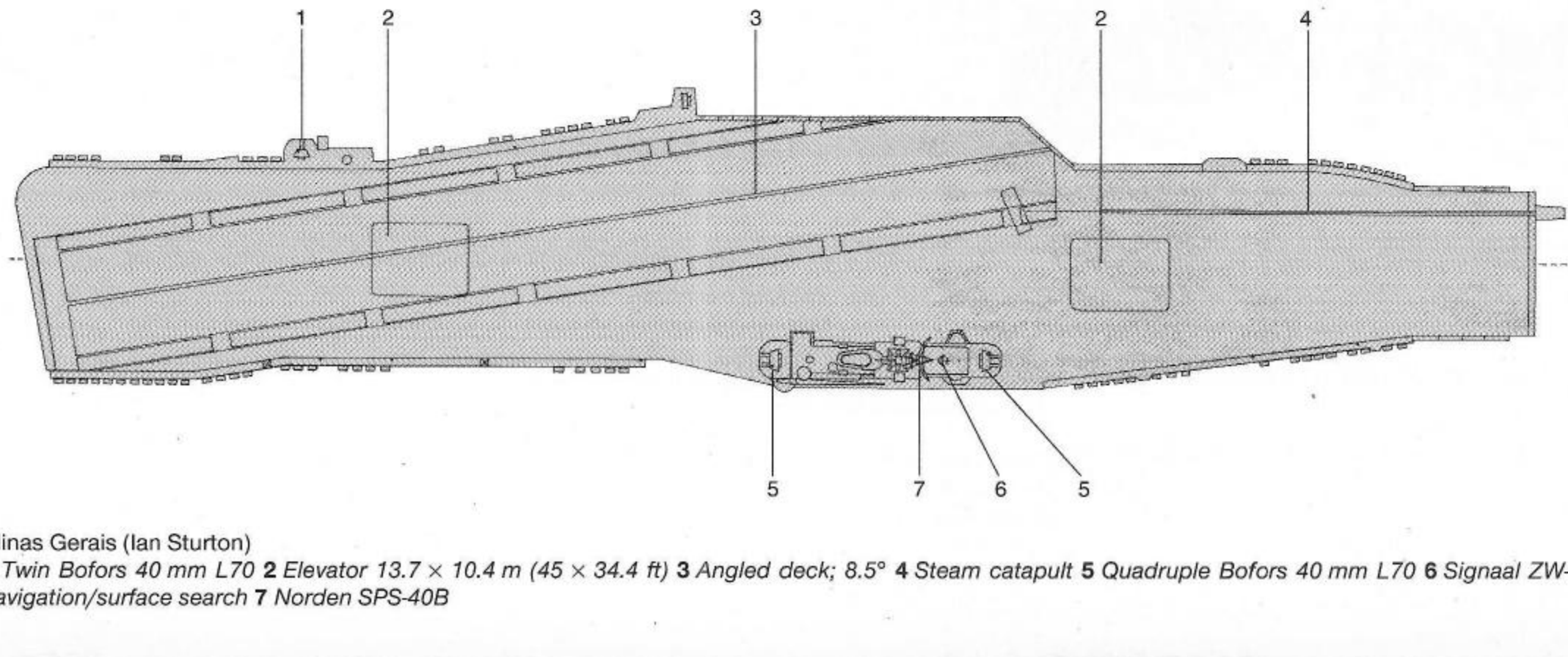
There are two Mk 63 GFCS (Gun Fire-Control Systems). Like the Mk 52, it is based on the Mk 51 GFCS, but has a tracking radar on the gun mount.

Specifications
Lead angle: 20°
Detection range: 33,800 m (110,864 ft) (approx)
Effective range: 730-6,400 m (2,395.1-20,998 ft)

RADARS

Type	SPS-40B	AWS-4	ZW-06	SPG-34 (Mk 34)	Skanter Mil-Par
Maker	Norden	Plessey	Signaal	—	Terma (Denmark)
Role	Air search	Air/surface search	Navigation/surface search	Fire control	Carrier-control approach
Band	B (400-450 MHz) 10 channels	D/E	H/I	H/I	I/J
Beam	11 × 19°	1.9 × 30°	0.9 × 19°	3°	<2° horizontal 20° ±1° vertical
Peak Power Average	200 kW	75 kW	60 kW	25-35 kW	20 kW
Gain	21 dB	32 dB	32 dB	30 dB	>28.5 dB
Pulsewidth	60 µs (compressed to 1.0)	1/0.3 µs	0.06/0.6 µs	0.3 µs	0.06 ±0.1 µs
PRF	300 pps	680/1,360 pps	4,000/2,000 pps	1,800 pps	Short: 4,400 Hz Long: 2,200 Hz
Scan rate	7.5/15 rpm	10/20 rpm	24 rpm	—	up to 30 rpm
Typical range	175 n miles (320 km)	80-110 km at 12,000 m on 4 m² target or 85 km at 9,000 m for max resolution	Surface target (10 m²) — 14 n miles. Aircraft at 14 n miles at 20,000 ft	Acquisition by nodding scan (4.5 × 34.5° field of view; acquisition by conical scan (4.5° cone). Accuracy is 14 m ±0.1% of range	

AVIATION



Minas Gerais (Ian Sturton)
1 *Twin Bofors 40 mm L70* **2** *Elevator 13.7 × 10.4 m (45 × 34.4 ft)* **3** *Angled deck; 8.5°* **4** *Steam catapult* **5** *Quadruple Bofors 40 mm L70* **6** *Signaal ZW-06 navigation/surface search* **7** *Norden SPS-40B*

AVIATION FACILITIES

Specifications
Flight deck: 210.3 × 36.4 m (690 × 119.6 ft)
Height above sea: 17.2 m (56.43 ft)
Angled deck: 8.5°
Hangars: 2 with total size — 135.6 × 15.8 × 5.3 m (445 × 52 × 17.5 ft)
Elevators: 2 on the centreline, 1 serving each hangar, each 13.7 × 10.4 m (45 × 34 ft); 20 t load
Arrester cables: 3

FIXED-WING AIRCRAFT

Northrop Grumman S-2G Tracker
Six Northrop Grumman S-2G piston-engined ASW aircraft.

Specifications
Wing span: 22.12 m (72.58 ft)
Length overall: 13.26 m (43.5 ft)
Height overall: 5.06 m (16.58 ft)
Weight, empty: 8,505 kg (18,750 lb)
Max take-off weight: 13,222 kg (29,150 lb)
Max speed at S/L (clean): 230 kts (426 km/h)
Cruising speed at optimum altitude: 180 kts (333 km/h)
Range, no reserve: 1,000 n miles (1,853 km)
Engines: 2 Wright R-1820-82WA Cyclone radial engines, each with five-bladed reversing propeller
Accommodation: 4 (pilot, co-pilot, radar operator, MAD operator)
Role equipment: Underwing pylons (6), weapons bay (1), sonobuoy ports (32), depth charge racks (2), explosive charge dispenser (for sound ranging) (60 charges)
Sensors: APN-122 Doppler radar; AQA-3 Jezebel acoustic search equipment using sonobuoys; sniffer passive submarine exhaust detector; Julie active acoustic echo ranging; ASQ-10 MAD; retractable 75 kW X-band search radar antenna; underwing searchlight
Weapons: Weapons bay: homing torpedoes (2), or Mk 101 depth bomb (1), or 175 kg (385 lb) depth charges (4). Underwing pylons (6): Torpedoes, 127 mm (5 in) rockets, Zuni rockets, 113 kg (250 lb) bombs

Manufacturer/Contractor
Northrop Grumman, Los Angeles, California, USA.

HELICOPTERS

Agusta/Sikorksy SH-3D/H Sea King
Four Agusta SH-3D/H Sea King ASW helicopters.

Specifications
Main rotor diameter: 18.90 m (62.0 ft)
Length (both rotors turning): 21.91 m (71.88 ft)
Fuselage length: 16.69 m (54.75 ft)
Height to rotor head: 4.74 m (15.55 ft)
Rotor disc area: 280.5 m² (3,019 sq ft)
Max take-off weight: 9,525 kg (21,000 lb)
Max speed (never exceed): 144 kts (267 km/h)
Typical cruising speed: 120 kts (222 km/h)
Range with max standard fuel: 630 n miles (1,166 km)
Engines: 1—1,118 kW (1,500 shp) General Electric T58-GE-100 turboshafts. Normal fuel capacity 3,180 litres (840 US gallons)
Role equipment: Underwing pylons (6), torpedo bay, sonobuoy ports (32), depth charge racks (2), search radar, FLIR, MAD
Accommodation: 4 (pilot, co-pilot, two sonar operators)
Sensors: Low-frequency 360° AQS-18/AQS-13F sonar; Doppler radar; SMA/APS-707 radar (chin radome)
Weapons: Homing torpedoes (A 224AS, Mk 44 or Mk 46) (2 or 4); or depth charges (4), or Exocet AM39 anti-ship missiles (2)

Manufacturer/Contractor
Agusta SpA, Rome, Italy.

UH-14 Aerospatiale Super Puma
Three UH-14 Aerospatiale Super Puma helicopters.

Specifications
Main rotor diameter: 16.20 m (53.125 ft)
Length, rotors turning: 19.50 m (63.97 ft)
Height to rotor head: 4.60 m (15.09 ft)
Main rotor disc area: 206.0 m² (2,217.4 sq ft)
Weight, empty: 4,660 kg (10,274 lb)
Max speed, (never exceed): 177 kts (327 km/h)
Fast cruise: 150 kts (277 km/h)
Economic cruise: 133 kts (247 km/h)
Range, no reserves: 460 n miles (851 km)
Endurance, standard fuel, at 70 kts (130 km/h): 4 h 54 min
Engines: 2 Turbomeca Makila 1A2 rear drive free turbines; max continuous power from single engine 1,666 kW (2,232 hp)
Accommodation: Military operation 1 pilot in VFR, 2 in IFR; military capacity, squad chief plus 28 troops
Sensor: Thomson-CSF Varan radar

Manufacturer/Contractor
Aerospatiale, Paris, France.

UH-12 Eurocopter AS 350 Ecureuil
Two Eurocopter AS 350 ECUREUIL (Brazilian Navy designation: UH-12 Esquilo) five/six-seat light general purpose helicopters.

Specifications
Main rotor diameter: 10.69 m (35.07 ft)
Length, rotors turning: 12.94 m (42.45 ft)
Length, fuselage: 10.93 m (35.86 ft)
Height overall: 3.14 m (10.3 ft)
Main rotor disc area: 89.75 m² (966.1 sq ft)
Weight, empty: 1,146 kg (2,526 lb)
Weight, max take-off: 2,100 kg (4,630 lb)
Max speed, (never exceed): 155 kts (287 km/h)
Max cruise: 126 kts (234 km/h)
Max rate of climb: 456 m (1,500 ft)/min
Service ceiling: 4,800 m (15,750 ft)
Range, no reserve at economic cruise: 394 n miles (730 km)
Weapons: 20 mm Giat M621 gun, or FN Herstal TMP twin 7.62 mm machine gun pods, or Thomson Brandt 68.12 launchers for 68 mm rockets (12), Forges de Zeebrugge launchers for 7—2.75 in rockets (7), or ESCO HeliTOW anti-tank missile system

Manufacturer/Contractor
Eurocopter, Paris, France.

Minas Gerais *with an S-2 Tracker and a UH-13 Ecureuil ranged on deck* (Brazilian Navy)

PROPULSION

Specifications
System: Steam
Boilers: 4 Admiralty pattern
Pressure: 28.1 kg/cm² (400 psi), 371°C (700°F)
Turbines: 2 Parsons geared turbines
Power output: 30 MW (40,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

This 'light fleet carrier' entered service with the UK Navy in 1945 as HMS *Vengeance* and in 1948 was specially fitted out for an experimental, protracted cruise in Arctic waters. The ship was subsequently lent to the RAN in 1953, pending the availability of HMAS *Melbourne*, another light fleet carrier, which had been bought by Australia and was fitting out prior to delivery. *Vengeance* was employed by the RAN until late 1954 when it was reduced to a training role and then returned to the Royal Navy in June 1955. It was purchased by the Brazilian Government on 14 December 1956, the first aircraft carrier to be bought by a South American navy although it became the second to enter service as the Argentine *Independencia* (ex-*Warrior*) was commissioned first.

MODERNISATION

On purchasing the carrier the Brazilian Navy had it moved to Rotterdam for reconstruction, which included increasing steam capacity by retubing the boilers, installing new lifts and improving aircraft-handling capacity by fitting a MacTaggart-Scott single-track steam catapult for launching and upgrading the arrester wires to enable them to recover 13,600 kg (30,000 lb) aircraft at 60 kts. The work alsq included the installation of the 8.5° angled deck, mirror-sight deck landing system and armament fire control, as well as a new island and radar equipment.

A second refit was completed in 1981 and yet further modernisation was undertaken from July 1991 to October 1993. This included new carrier-control approach (CCA) radars, electronics and communications, tactical control system (SICONTA) incorporating IPqM/Datanav TTI-2700 consoles, datalink YB; retubing of boilers and other major engine overhauls. Guns have been removed in favour of Sadral twin launchers for Mistral SAM fitted in 1994, but could be replaced, if required.

Minas Gerais *in 1992*

SHIPBOARD AIRCRAFT

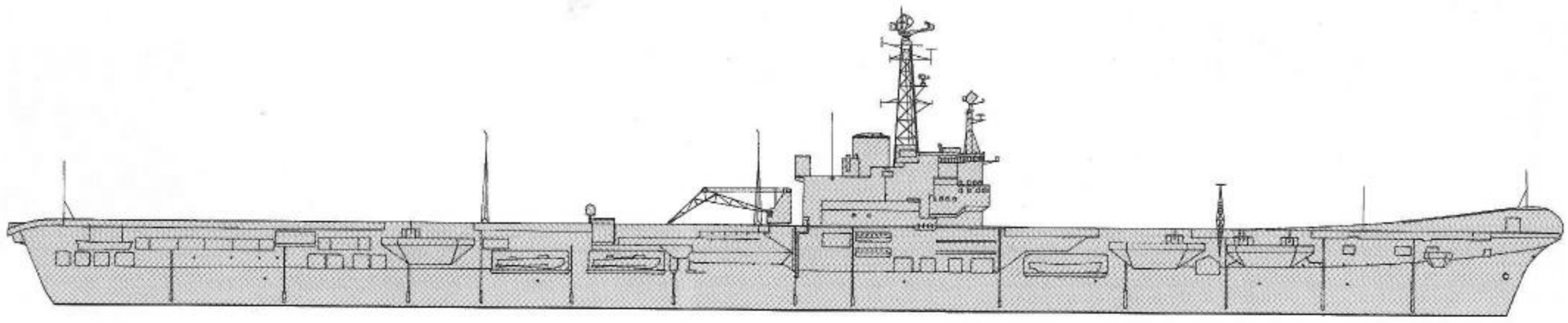
Throughout its career with the Brazilian Navy, *Minas Gerais* has operated as an ASW carrier, although a proposal to purchase 12 Douglas A-4 Skyhawks was announced in 1984 only to be cancelled two years later. The primary ASW aircraft is the Grumman S-2E Tracker, of which the Brazilian Navy operates eight, with a further four S-2As used for transport and training. One of the S-2Es was rebuilt and modernised by Embraer between 1989 and 1992; it was fitted with Thomson-CSF Varian radar, FLIR and MAD equipment, and re-engined with Pratt & Whitney Canada PT6A-67AF turboprops. Plans for similar rebuilds for the rest of the fleet have, however, been shelved.

THE FUTURE

Like the other former British light fleet carriers, *Minas Gerais* is now reaching the end of its useful life and the Brazilian Navy has been considering a replacement for some time. One possibility reported to be under consideration is a new ship in the 35,000 to 40,000 tonne class, with a speed of 28 kts and capable of carrying some 35 to 40 aircraft; it would be fitted with two steam catapults and have modern anti-aircraft defences. To judge by the French experience with the replacement for the 'Clemenceau' class, this would be an extremely expensive project and difficult to sustain in parallel with the nuclear-propelled submarine programme. Alternatively, the Brazilian Navy is also considering a smaller 25,000 tonne ship for use as a helicopter carrier.

Minas Gerais

VIKRANT



Vikrant (Ian Sturton)

GENERAL SPECIFICATIONS

Country: India
Type: British light fleet carrier

Class: MAJESTIC

Active: 1

Displacement:
standard: 16,000 t
full load: 19,500 t
Length: oa 213.4 m (700 ft); wl 192 m (630 ft)
Beam: oa 39 m (128 ft); wl 24.4 m (80 ft)
Draught: 7.3 m (24 ft)

Speed: 24.5 kts
Range: 12,000 n miles at 14 kts; 6,200 n miles at 23 kts

Complement: 1,075 peace; 1,345 war

SHIPS

VIKRANT R 11

Builder	Vickers-Armstrong, Tyne, UK
Laid down	14 Oct 1943
Launched	22 Sep 1945
Work suspended	May 1946
Sold	Jan 1957 (India)
Commissioned	4 Mar 1961 (India) (Vikrant)

Vikrant *(R 11), showing the typical British light fleet carrier lines*

WEAPONS SYSTEMS

GUNS

Bofors 40 mm/70 AA gun
Seven Bofors 40 mm/70 AA guns.

Specifications
Traverse: 360° (nominal) at 90°/s
Elevation: −3 to +85° at 60°/s
Rate of fire: 300 rds/min
Muzzle velocity: 1,005-1,025 m/s (3,297-3,363 ft/s)
Max range:
anti-surface: 6.5 n miles (12 km)
anti-air: 2.2 n miles (4,000 m)
Ammunition weight: 2.4 kg (5.3 lb)
Projectile weight: 0.96 kg (2.11 lb)
Power: 440 V, 3-phase, 60 Hz.
Crew: 4

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

IPN-10
IPN-10 is the export version of SADOC 2 *(Systema Direzione della Operazioni di Combattimento)*, which was developed by Selenia (now Alenia Elsag Sistemi Navali) in the late 1970s and built under licence in India by Bharat Electronics. The SADOC 2/IPN-10 data handling system is designed to produce an up-to-date picture of the tactical situation within the vicinity of both the *Vikrant* and its task group. SADOC 2/IPN-10 is a mainframe system, designed primarily to acquire, process and present data acquired by *Vikrant's* principle sensors, which comprise the LW 08 and DA 05 radars, and the Graseby 750 sonar. The system can, however, also be used for other functions, including evaluation, threat evaluation, weapons control, ECM management, aircraft control, conducting ASW operations, and datalink databank management. In addition to the data received from onboard sensors the system is also capable of receiving and processing data received from offboard sensors via datalinks.

There are several Selenia (now Alenia) 32-bit CDG-3032 central processing units (CPU), each with a 128 k memory, one of which normally acts as the primary, with another acting as an immediate backup in the event of system failure. Each of the consoles also contains a Selenia (now Alenia) 16-bit NDC-160 minicomputer, with 64 k memory. Both types possess mass memory modules for handling programmes and large amounts of data and interface with each other via a 10 Mbit/s serial databus. The basic software of the latter is under the control of two TAVITAC operating systems; the disk operating system and a time-sharing executive. The CPUs are supported by a Tape Cassette Unit (TCU) with three transporters to provide initial programme loading by means of cartridge cassette magnetic tape. They are also used for data recording and data retrieval. Input/output (I/O) expander and

converter units interface with external systems and an I/O terminal to monitor the system and to provide offline hard copy records. The system is also associated with radar tracking units (RTU) for radar video extraction and automatic tracking and radar central units (RCU) for distributing radar data.

There are two types of console, the SVC-16 single-operator vertical console with a 40.64 cm (16 in) CRT display (SVC-16) and the MHC-22 multi-operator horizontal console with 55.88 cm (22 in) CRT display. The SVC-16 is used mainly for sensor management and control functions while the triple-operator MHC is used for evaluation and command functions. Both incorporate their own NDC-160 mini-processor and have a synthetic display capability including alphanumerics which are refreshed at a rate in excess of 30 Hz. SVC-16 display is monochrome but that of the MHC is available in four colours, but both may be used for raw video presentation. The MMI in both systems consists of a flexible data entry keyboard, in which each button is capable of 48 functions, and rollerballs. They also include a 17.78 cm (7 in) alphanumeric display with 16 rows and 40 columns of ASCII characters.

Manufacturers/Contractors

Bharat Electronics Ltd (BEL), Bangalore, India.
Alenia Elsag Sistemi Navali, Rome, Italy.

RADARS

Type	LW-08	DA-05	ZW-06
Maker	Signaal	Signaal	Signaal
Role	Air search	Air/surface search	Surface search
Band	D/E (6 presets between 1,250-1,350 MHz)	D/E (6 presets between 2,900 and 3,100 MHz)	I
Beam	2.2 × csc² to 40°	1.5 × 8° (csc² to 40°)	0.9 × 19°
Peak Power Average	150 kW, pulse compressed; 5.2 kW	1,200 kW	60 kW
Gain	30 dB	32.2 dB	32 dB
Pulsewidth	35/90 µs	1.3/2.6 µs	0.06/0.6 µs
PRF	1,000/500 pps	1,000/500 pps	4,000/2,000 pps
Scan rate	7.5/15 rpm	10/20 rpm	24 rpm
Typical range	145 n miles at 26,000 m for 2 m² target	72-84 n miles for 2 m² target at about 60,000 ft	10 m² surface target — about 14 n miles. Aircraft at 20,000 ft - 14 n miles

SONAR

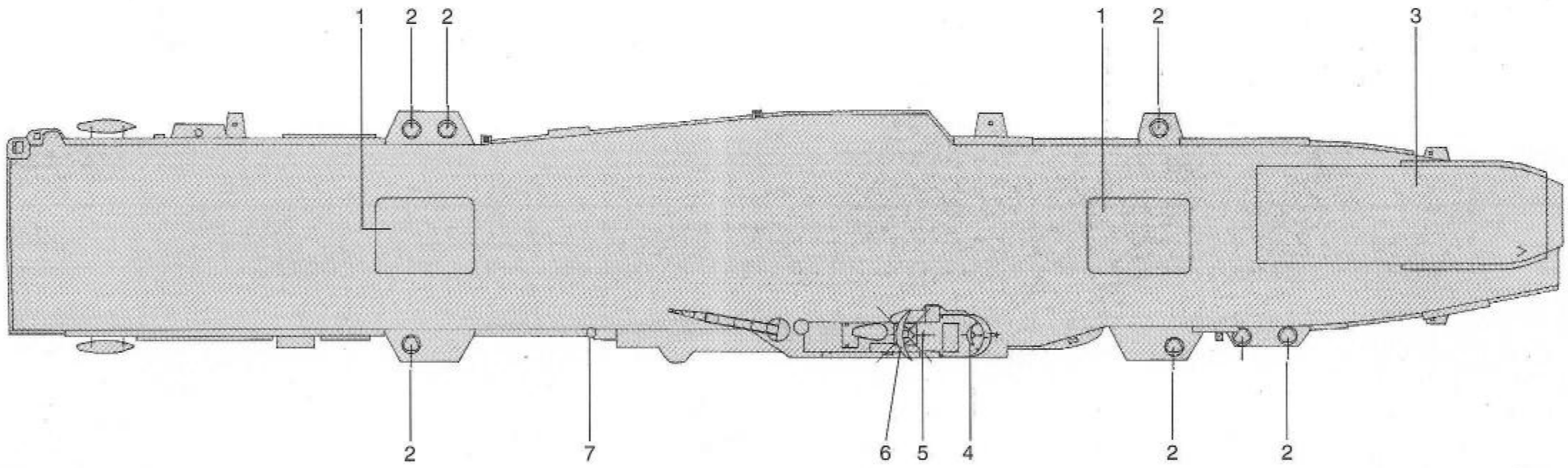
Graseby 750

One Graseby 750 hull-mounted, active search and attack sonar. This is a solid-state development of the RN's Type 184M, providing a 360° scan and incorporating both active and passive modes of operation, providing range, bearing and target Doppler data directly to the fire control computer, and using a circular 32-stave transducer array. The Graseby 750 provides a dual-frequency transmission and three receiver systems, the latter comprising: an all-round search and tracking PPI system with eight receiving channels; a four-beam sector search Doppler system with B-scan display; and a continuous torpedo warning system with its own display.

Manufacturer/Contractor

Graseby Marine (Graseby Dynamics Ltd), Watford, UK.

AVIATION



Vikrant (Ian Sturton)
1 *Centre-line elevators* **2** *Single Bofors L40/70* **3** *Ski-ramp; 9.75°* **4** *Signaal ZW-06* **5** *Signaal DA-05* **6** *Signaal LW-08* **7** *Satellite communications antenna*

AVIATION FACILITIES

Specifications

Flight deck: 210 × 34 m (690 × 112 ft)
Hangar: 1 hangar, total size 135.6 × 15.8 × 5.3 m (445 × 52 × 17.5 ft)
Ski ramp: 12°
Elevators: 2 centreline

FIXED-WING AIRCRAFT

BAe Sea Harrier FRS Mk 51

Six BAe Sea Harrier FRS Mk 51 single-seat strike and reconnaissance fighters, with a total capacity for 30.

Specifications

Wing span:
normal: 7.70 m (25.25 ft)
ferry: 9.04 m (29.66 ft)
Length:
overall: 14.50 m (47.58 ft)
nose folded: 12.73 m (41.75 ft)
Height overall: 3.71 m (12.17 ft)
Weights:
operating, empty: 6,374 kg (14,052 lb)
max fuel internal: 2,295 kg (5,060 lb)
external: 2,404 kg (5,300 lb)
Max weapon load:
STO: 3,630 kg (8,000 lb)
VTO: 2,270 kg (5,000 lb)
Max take-off: 11,880 kg (26,200 lb)
Max speed, high altitude: Mach 1.25
Max level speed, low altitude: 640+ kts
Cruising speed:
high altitude: Mach 0.8+
low altitude: 350-450 kts
Attack radius: 250 n miles (463 km; 288 miles)
Engine: 1 Rolls-Royce Pegasus Mk 104 (95.6 kN; 21,500 lb st)
Accommodation: 1 (pilot only, on Martin-Baker Mk 10H zero/zero rocket ejection seat)
Weapons: 30 mm guns, bombs, rockets and flares of UK and US designs

HELICOPTERS

Westland Sea King Mk 48

Nine Westland Sea King Mk 48 B/C ASW helicopters.

Specifications

Main rotor diameter: 18.90 m (62.0 ft)
Rotor disc area: 280.5 m² (3,019 sq ft)
Length overall (both rotors turning): 22.15 m (72.66 ft)
Fuselage length: 17.02 m (55.83 ft)
Height to rotor head: 4.74 m (15.54 ft)
Max take-off weight: 9,752 kg (21,500 lb)
Max speed (never exceed): 144 kts (267 km/h)
Typical cruising speed: 120 kts (222 km/h)
Range with max standard fuel: 630 n miles (1,166 km)
Engines: 2—1,092 kW (1,465 shp) Rolls-Royce Gnome H.1400-IT turboshafts. Normal fuel capacity 3,180 litres (840 US gallons)
Role equipment: 6 underwing pylons, torpedo bay, 32 sonobuoy ports, 2 depth charge racks, search radar, FLIR, MAD
Accommodation: 4 (pilot, co-pilot, two sonar operators)
Sensors: Low-frequency 360° AQS-18/AQS-13F sonar; Doppler radar; SMA/APS-707 radar (chin radome)
Weapons: 2 or 4 homing torpedoes, or 4 depth charges or 2 Sea Eagle anti-ship missiles

HAL Chetak

One HAL Chetak (licence-built Aerospatiale Alouette III) search and rescue helicopter.

Specifications

Main rotor diameter: 11.02 m (36.15 ft)
Rotor disc area: 95.38 m² (1,026.6 sq ft)
Length overall, rotors turning: 12.84 m (42.13 ft)
Height to rotor head: 2.97 m (9.45 ft)
Weight, empty, standard: 1,230 kg (2,711 lb)
Max take-off weight: 2,200 kg (4,850 lb)
Max speed (never exceed) at S/L: 113 kts (210 km/h)
Max cruising speed at S/L: 100 kts (185 km/h)
Range with max fuel at S/L: 257 n miles (477 km)
Endurance: 3 h
Engine: 1–649 kW (870 shp) HAL-built Turbomeca Artouste IIIB turboshaft, derated to 410 kW (550 shp) for max continuous operation
Accommodation: 7 (pilot plus 6 persons)
Weapons: 7.62 mm machine gun (with 1,000 rds), or 20 mm gun (with 480 rds), or 2/4 wire-guided missiles, or 68 mm rocket pods

PROPULSION

Specifications

System: Steam
Boilers: 4 British Admiralty pattern
Pressure: 28 kg/cm² (400 psi)
Operating temperature: 370°C (700°F)
Turbines: 2 Parsons turbines
Output power: 30 MW (40,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

This ship was originally laid down as *Hercules,* the first of the second group of British light fleet carriers — the 'Majestic' class. The hull was launched in 1945 but work was suspended in May 1946 when the ship was structurally almost complete and 75 per cent fitted out. After a period of indecision, the ship was purchased by the Indian Navy to become its first aircraft carrier and taken in hand by Harland & Wolff, Belfast, UK, in April 1957 for completion. An angled deck was fitted, together with a steam catapult and mirror landing-aid, and the ship was commissioned in March 1961 as INS Vikrant, with an air wing comprising Hawker Sea Hawk turbojet fighter-bombers and Breguet Alizé turboprop ASW aircraft.

MODERNISATION

Vikrant has had a large number of major refits. The first was from January 1979 to January 1982, which included the replacement of engines and boilers, together with the installation of new sensors and a combat information centre. This was followed by the second, shorter refit in 1983, which adapted the ship to operate Sea Harriers, but without a ski ramp, since the flat deck, catapults and arrester gear were still required to operate the Alizé fixed-wing aircraft. The third refit was from 1987-89 and included the fitting of a 9.75° ski ramp, to enable the Sea Harriers to be operated to their full potential, although the original structure was not strong enough for a fully loaded Sea Harrier and further modifications had to be made in 1990/91. Other modifications during this refit included fitting new radars and other electronic equipment, all of which should enable the ship to serve through to 1997 at least.

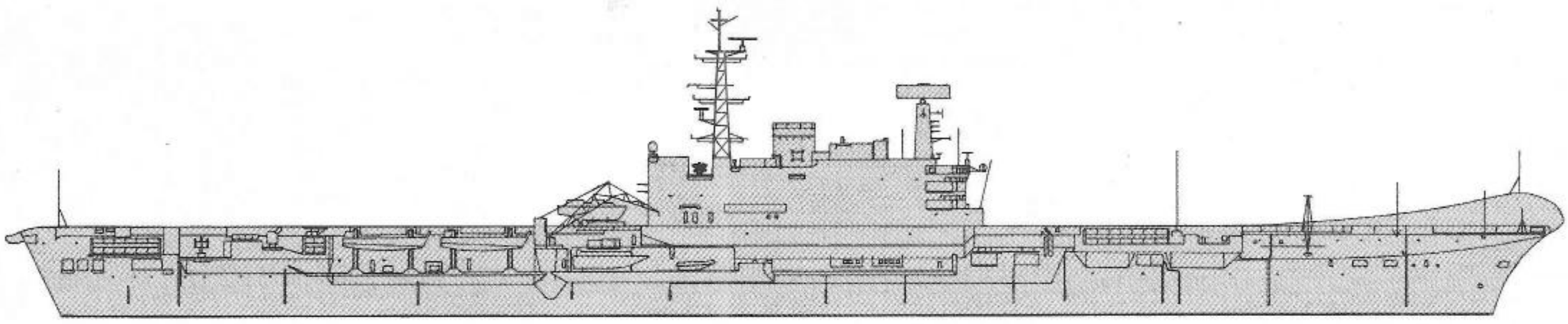
Vikrant *(R 11) in 1994, showing round-down and the height of the new ski ramp. Mast top radar antenna is the Signaal LW 08* (H & L van Ginderen Collection)

THE FUTURE

Like the other remaining former British light fleet carriers, both the Indian carriers are in increasingly urgent need of replacement, *Vikrant* much more so than *Viraat*. Various plans have already been made, amended and cancelled to achieve this, the first being an announcement in 1989 that two new aircraft carriers would be built, with the first joining the fleet in time for the 50th anniversary of independence in 1997. These would have been conventionally powered versions of the French *Charles De Gaulle* design, built in India and would have had a maximum speed in excess of 30 knots.

In mid-1991 the Committee on Defence Expenditure told the Indian Navy to abandon plans for large carriers and shift the design effort to Italian *Garibaldi* type, which led to the cancellation of the deal with France. Then Russia, in its post-Cold War run-down offered the Project 1143.4 aircraft carrier, *Admiral Gorshkov,* for sale, but the price demanded by Russia was too great. India would like a second carrier but will not be capable of deploying such a unit, at least in the medium term.

VIRAAT



Viraat (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: India
Type: British light fleet carrier

Class: HERMES

Active: 1

Displacement:
standard: 23,900 t
full load: 28,700 t
Length: oa 226.9 m (744.3 ft); wl 208.8 m (685 ft)
Beam: oa 48.8 m (160 ft), wl 27.4 m (90 ft)
Draught: 8.7 m (28.5 ft)

Speed: 28 kts

Complement: 1,350 (143 officers) (incl air group) (plus 750 commando troops for short period)

SHIPS

VIRAAT R 22

Builder	Vickers-Armstrong, Barrow-in-Furness, UK
Laid down	21 Jun 1944
Launched	16 Feb 1953
Commissioned	18 Nov 1959 (RN) (HMS *Hermes*)
Converted	
commando carrier	1971-1973
ASW carrier	1976-1977
V/STOL carrier	1980-1981
Sold	12 May 1987 (India)
Commissioned	20 May 1987 INS *Viraat*

Viraat *(R 22) in August 1994* (H & L van Ginderen Collection)

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Short Seacat GWS.22
Two Short Seacat GWS.22 quadruple launchers.

Specifications
Missile
Length: 1.48 m (4.8 ft)
Diameter: 19 cm (0.6 ft)
Wing span: 65 cm (2.1 ft)
Weight: 68 kg (149.9 lb)
Speed: Mach 0.8
Range: 2.7 n miles (5 km)
Radar: Type 904 (see radar table on opposite page)

Manufacturer/Contractor
MSI-Defence Systems (formerly Short Brothers plc), Belfast, UK.

GUNS

Oerlikon 20 mm cannon
Two Oerlikon 20 mm cannon.

Specifications
Calibre: 70
Muzzle velocity: 835 m/s (2,739.6 ft/s)
Range:
surface target: 1.5 km (0.81 n miles)
air target: 1.15 km (0.62 n miles)
Rate of fire: 450 m/s (1,476.4 ft/s)
Round weight: 241 g
Projectile: 122 g
Elevation: −15 to +90°

Manufacturer/Contractor
Royal Ordnance, Medium Calibre Gun Division, UK.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Radar intercept and jamming fitted; types not known.

DECOYS

VSEL Corvus
Two VSEL Corvus chaff launchers.

Specifications
Modes of operation: Distraction decoy; centroid decoy
Bearing arc (launcher axis): 60-120° (normal)
Bearing arc (tube axis): 15-165° (max)
Launcher weight: 585 kg (1,290 lb)
Off-launcher equipment weight: 42 kg (92.6 lb)
Tube diameter: 195 mm (7.67 in)
Tube length: 1.6 m (5.25 ft)
Weight (empty): 25 kg (55 lb)

Manufacturer/Contractor
VSEL, Barrow-in-Furness, Cumbria, UK.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

CAAIS action data automation

CAAIS (Computer Assisted Action Information System) was developed in the early 1960s and the first production system, DBA (2), entered service with HMS *Amazon* in 1974, while DBA (3) was installed in the aircraft carrier HMS *Hermes*, as part of her conversion to the anti-submarine role. This was completed in January 1977 and the system was still aboard when she was sold to India in May 1987. CAAIS is a tactical picture compilation system, providing automatic tracking of air and surface targets, processing sonar and EW inputs, operating a digital datalink, designating targets, and providing torpedo control and vectored attack orders for ASW helicopters. DBA (3) is a mainframe system using the Ferranti FM1600B computer and Decca displays. The hardware includes a three-cabinet digital suite housing a 24-bit computer, operating at 200 Kips and with a 780 k memory, as well as a datalink terminal. In addition there are peripheral control units which include radar extraction units, encoder/decoders, display drive unit and the MMI control units. The last two elements support the display system which includes up to six CA 1600 horizontal displays. The datalink, known as Link X in NATO navies, is a serial transmission, medium-speed (1,200 baud) link suitable for HF and UHF channels. The programming language is Coral 66.

Manufacturer/Contractor

Ferranti Naval Systems Ltd, UK.

SONAR

Type 184 sonar

The Type 184M hull-mounted, active/passive sonar was installed when Viraat was still serving with the RN. It is a 360° scanning sonar providing range, bearing and target Doppler data to the fire control computer. The equipment provides a dual-frequency transmission and three receiver systems, comprising an all-round search and tracking PPI system with eight receiving channels; a four-beam sector search Doppler system with B-scan display; and a continuous torpedo warning system with its own display.

Specifications

Transducer: 32-stave circular array
Dome (retractable): 4 m (13.1 ft) long, 1.63 m (5.3 ft) wide, 1.55 m (5.1 ft) deep
Operating frequency: 7.5 kHz

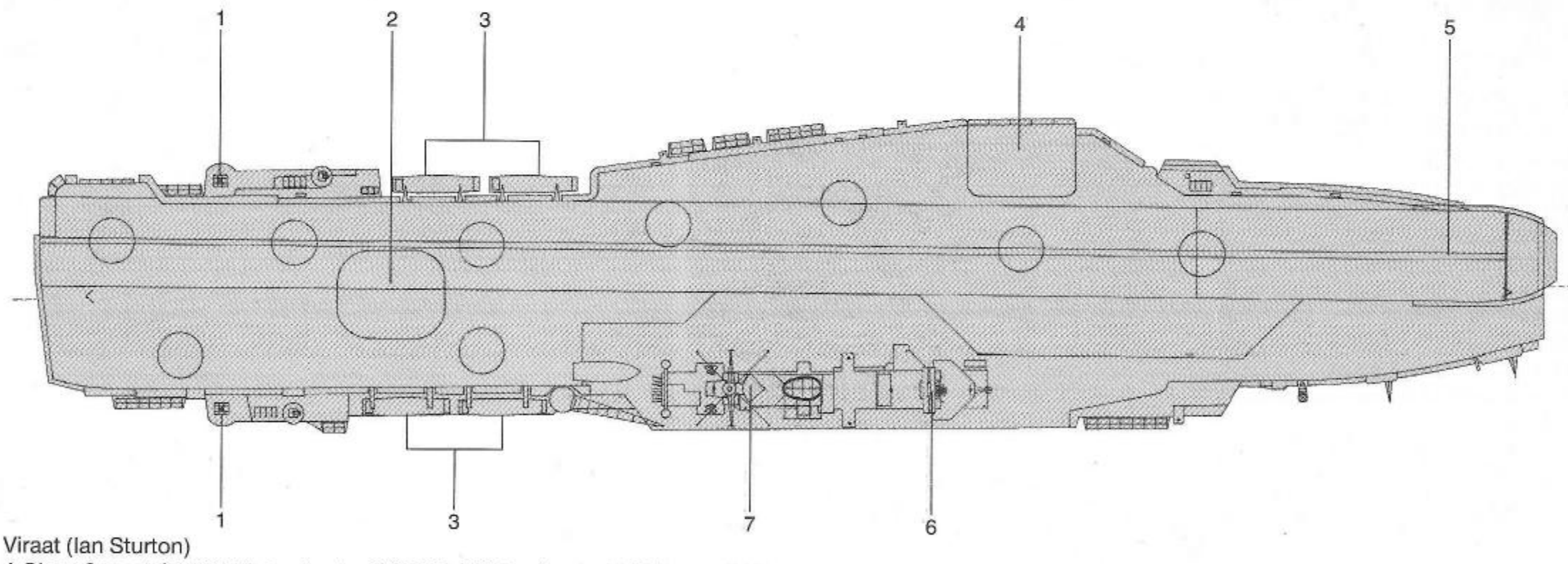
Manufacturer/Contractor

Graseby Marine (Graseby Dynamics Ltd), Watford, UK.

RADARS

Type	Type 966	Type 994	1006	Type 904
Maker	Marconi	Plessey	Kelvin Hughes	
Role	Air search	Air/surface search	Navigation	Part of GWS.22 fire-control system for Sea Cat SAM
Band	A/B	D/E	I	I
Beam	12 × 40°	1.9 × 30°	1 × 18°/0.75 × 18°	2°
Peak Power	450 kW	750 kW	25 kW	50 kW
Gain	20 dB	32 dB	31 dB/34 dB	37.5 dB
Pulsewidth	3.8/10 µs	1/0.3 µs	0.8/0.25/0.75 µs	0.1 µs
PRF	400/200 pps	680/1,360 pps	1,600/800 pps	3,000 pps
Scan rate	8/10 rpm	10/20 rpm	24 rpm	Spiral/conical
Typical range	100+ n miles on 20 m² target	80-100 km on 4 m² target at 12,000 m height	64 n miles+	27,000 m (88,587 ft)

AVIATION



Viraat (Ian Sturton)
1 *Short Seacat SAM* **2** *Main elevator* **3** *LCVP* **4** *Side elevator* **5** *Ski jump (12°)* **6** *Marconi Type 996 radar* **7** *Signaal DA 05*

AVIATION FACILITIES

Specifications

Flight deck: 227.02 m (744.25 ft) × 48.82 m (160.08 ft)
Ski ramp: 12°
Elevators: 2 (1 centreline 16.46 × 13.4 m (54 × 44 ft); 1 deck-edge 16.55 × 10.67 m (54.3 × 35 ft); both max load 18,144 kg (40,000 lb))

FIXED-WING AIRCRAFT

BAe Sea Harrier FRS Mk 51

12 BAe Sea Harrier FRS Mk 51 are normally embarked, but with a maximum capacity of 30 under operational conditions.

Specifications

Wing span:
  normal: 7.70 m (25 ft 3 in)
  ferry: 9.04 m (29 ft 8 in)
Length:
  overall: 14.50 m (47 ft 7 in)
  nose folded: 12.73 m (41 ft 9 in)
Height overall: 3.71 m (12 ft 2 in)
Weights:
  operating, empty: 6,374 kg (14,052 lb)
  max fuel: internal 2,295 kg (5,060 lb)
  external: 2,404 kg (5,300 lb)
Max weapon load:
  STO: 3,630 kg (8,000 lb)
  VTO: 2,270 kg (5,000 lb)
Max take-off: 11,880 kg (26,200 lb)
Max speed, high altitude: Mach 1.25
Max level speed, low altitude: 640+ kts
Cruising speed:
  high altitude: Mach 0.8+
  low altitude: 350-450 kts
Attack radius: 250 n miles (463 km; 288 miles)
Engine: 1 Rolls-Royce Pegasus Mk 104 (95.6 kN; 21,500 lb st)
Accommodation: 1 (pilot only, on Martin-Baker Mk 10H zero/zero rocket ejection seat)
Weapons: 30 mm guns, bombs, rockets and flares of UK and US designs

Manufacturer/Contractor

BAe, Farnborough, Hants, UK.

Viraat *with five Sea Kings, two Chetak (Alouette III) and three Sea Harriers on deck* (92 Wing RAAF)

HELICOPTERS

Viraat's air wing normally includes seven helicopters, a variable mix, depending on the needs of the particular operation, of Westland Sea King and Kamov Ka-27 Helix.

Westland Sea King Mk 48 B/C ASW helicopter

Westland Sea King Mk 48 B or C ASW helicopter.

Specifications

Main rotor diameter: 18.90 m (62.0 ft)
Length overall (both rotors turning): 22.15 m (72.66 ft)
Fuselage length: 17.02 m (55.83 ft)
Height to rotor head: 4.74 m (15.5 ft)
Rotor disc area: 280.5 m² (3,019 sq ft)
Max take-off weight: 9,752 kg (21,500 lb)
Internal cargo capacity: 2,720 kg (6,000 lb)
Max speed (never exceed): 144 kts (267 km/h)
Typical cruising speed: 120 kts (222 km/h)
Service ceiling: 3,720 m (12,200 ft)
Range with max standard fuel: 630 n miles (1,166 km)
Engines: 2–1,092kW (1,465shp) Rolls-Royce Gnome H.1400-IT turboshafts. Normal fuel capacity 3,180 litres (840 US gallons)
Role equipment: 6 underwing pylons, torpedo bay, 32 sonobuoy ports, 2 depth charge racks, search radar, FLIR, MAD
Accommodation: 4 (pilot, co-pilot, 2 sonar operators)
Sensors: Low-frequency 360° AQS-18/AQS-13F sonar; Doppler radar; SMA/APS-707 radar (chin radome)
Weapons: 2 or 4 homing torpedoes, or 4 depth charges or 2 Sea Eagle anti-ship missiles

Manufacturer/Contractor

Westland, Yeovil, Somerset, UK.

Kamov Ka-27 Helix

Kamov Ka-27 ASW helicopter.

Specifications

Rotor diameter (each): 15.90 m (52.17 ft)
Rotor disc area (each): 198.5 m² (2,138 sq ft)
Length, excluding rotors: 11.30 m (37.08 ft)
Length, rotors folded: 12.25 m (40.19 ft)
Width, rotors folded: 4.00 m (13.13 ft)
Height to top of rotor head: 5.40 m (17.7 ft)
Weight, empty: 6,500 kg (14,330 lb)
Normal T-O weight: 11,000 kg (24,250 lb)
Max payload:
internal: 4,000 kg (8,818 lb)
external: 5,000 kg (11,023 lb)
Max level speed: 145 kts (270 km/h)
Max cruising speed: 124-129 kts (230-240 km/h)
Radius of action against submarine cruising at up to 40 kts (75 km/h) at depth of 500 m (1,640 ft): 108 n miles (200 km)
Armament: Ventral weapons bay for torpedoes, depth charges, other stores

Manufacturer/Contractor

Kamov Helicopters (VNTK), Lubertsy, Moscow Region, Russia.

PROPULSION

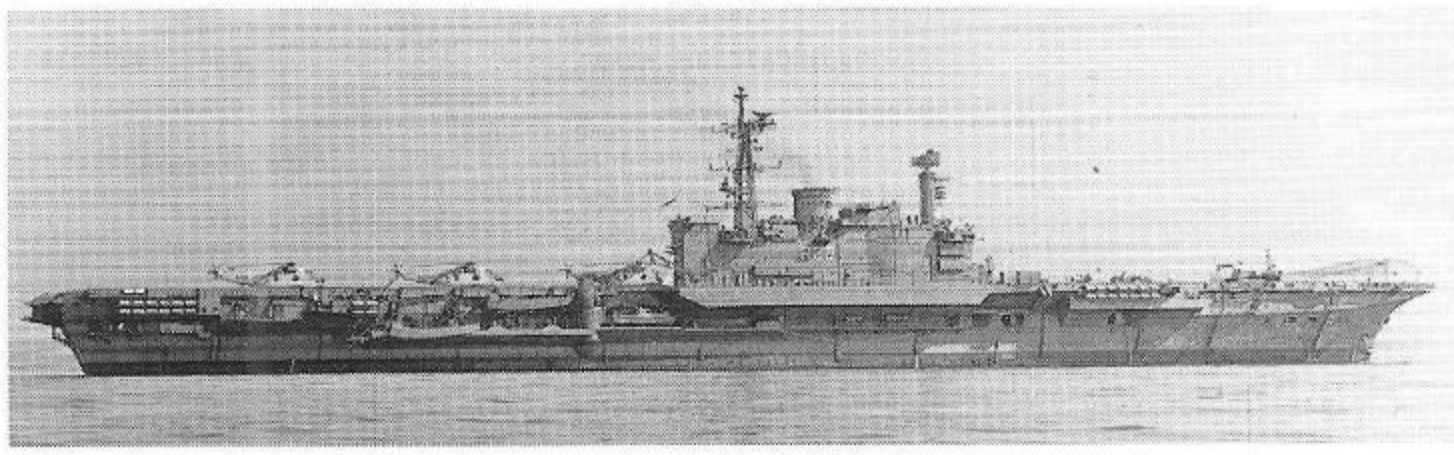
Specifications

System: Steam
Boilers: 4 British Admiralty pattern
Pressure: 28 kg/cm² (400 psi)
Operating temperature: 370°C (700°F)
Turbines: 2 Parsons geared turbines
Power output: 57 MW (76,000 shp)
Shafts: 2

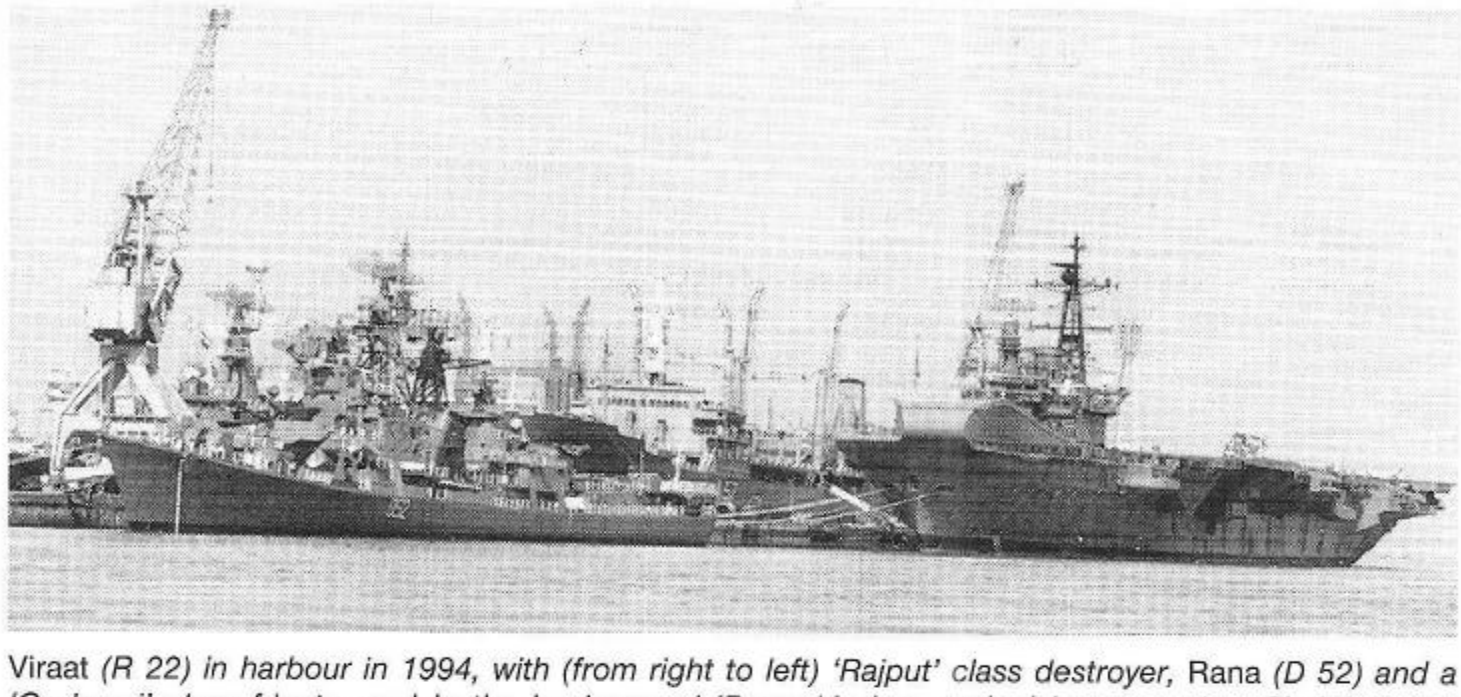
FURTHER INFORMATION

PROGRAMME

The hull was originally laid down in 1944 as HMS *Elephant*, the sixth of the 'Centaur' class of British light fleet carrier (see above), but was only partially completed when work was suspended to enable a radical redesign to be carried out. The ship was finally launched in 1954 as HMS *Hermes* and joined the fleet in 1959, by which time it had a 6.5° angled deck, a side elevator and a huge 'dustbin' antenna for the Type 934 long-range, 3D radar. Various modifications were carried out during a refit in 1964-66, but *Hermes* proved to be an awkward size for operational use, accommodating only 20 strike



Viraat *(R 22)* (H & L van Ginderen Collection)



Viraat *(R 22) in harbour in 1994, with (from right to left) 'Rajput' class destroyer,* Rana *(D 52) and a 'Godavari' class frigate, and in the background 'Deepak' class replenishment tanker,* Shakti *(A 57)* (H & L van Ginderen Collection)

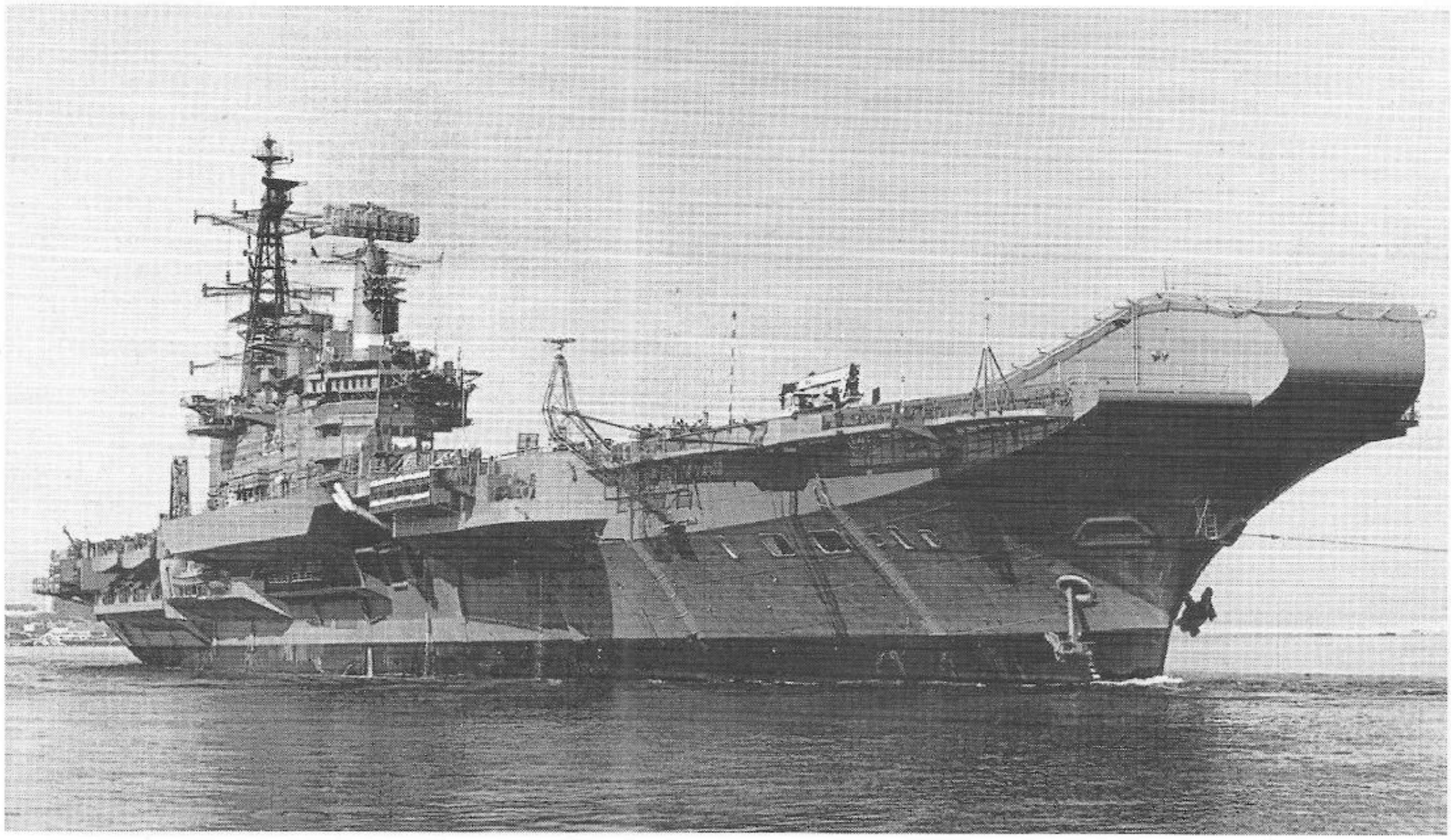
aircraft/fighters and eight ASW aircraft, and was then unable to operate the F-4K Phantom. As a result, the ship was converted during a 1971-73 refit to be a commando carrier. The arrester wires, catapults and other aids to fixed-wing flying were removed, to be replaced by landing-craft, troop-carrying helicopters and accommodation for a Royal Marine commando (approximately 700 men), plus its weapons, stores, vehicles and equipment.

In 1977 and in response to a change in operational priorities, *Hermes* was redesignated an ASW carrier (CVS), in which role it at first carried a mix of Sea King and Wessex ASW helicopters. The ship was subsequently altered yet again between May 1980 and May 1981, in order to carry Sea Harrier V/STOL fighters, for which a 12° ski ramp was fitted, although it was still capable of accommodating a 750-man Royal Marine commando, if required. The ski ramp was based on an original design by Lieutenant Commander D R Taylor, RN, and in its 12° version allows take-off load to be increased by 1,135 kg (2,500 lb) for the same take-off run, or, at the same weight, the take-off run to be reduced by 50-60 per cent.

At this time the official air wing comprised five Sea Harriers and nine Sea King Mk 2 helicopters, but on the outbreak of the 1982 Falklands (Malvinas) war *Hermes* sailed south as the flagship of the task force and managed to operate no less than 20 Sea Harriers and 10 Sea Kings.

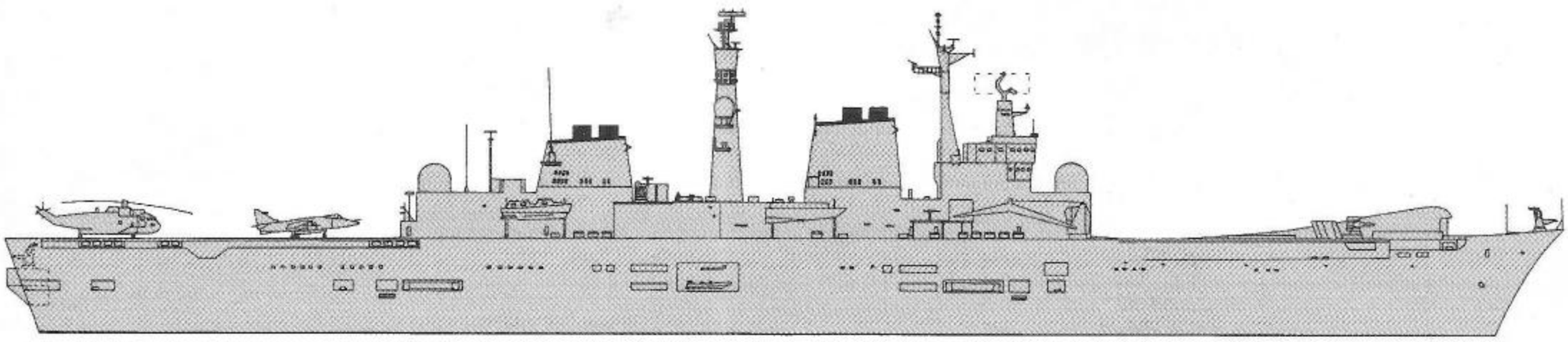
The British planned to either scrap or sell *Hermes* as a result of the 1981 defence cuts, but this was cancelled when the Falklands war broke out. Once the war was over, however, the ship was again put up for sale and in May 1986 it was purchased by India and went into Devonport Dockyard where it was commissioned into the Indian Navy as INS *Viraat* (Mighty) on 20 May 1987. The post-sale Devonport refit included new fire-control equipment, navigation radars, and deck landing aids. At the same time, the boilers were converted to take distillate fuel and the ship was also given improved NBC protection.

Viraat normally has a complement of no more than 12 or 18 Sea Harriers, leaving room for a greater mix of Sea King and Hormone helicopters. The engine room was flooded in September 1993, taking the ship out of service for several months. The ship was operational again in 1995 but must be taken out of service for a major refit in 1997-98. This will leave India without an operational aircraft carrier.



Viraat *(R 22) shortly after commissioning into the Indian Navy* (H & L van Ginderen Collection)

INVINCIBLE



Illustrious (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: United Kingdom
Type: Guided missile ASW support aircraft carrier (CVSS)

Class: INVINCIBLE

Built: 3
Active: 2

Displacement:
standard: 16,860 t
full load: 20,600 t
Length: oa 209.1 m (685.8 ft); wl 192.6 m (631.8 ft)
Beam: oa 36 m (118.1 ft); wl 27.5 m (90.2 ft)
Draught: screws 8 m (26 ft)

Speed: 28 kts
Range: 7,000 n miles at 19 kts

Complement: 685 (60 officers), plus 366 (80 officers) aircrew, plus up to 600 marines

SHIPS

INVINCIBLE (R 05)

Builder	Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Laid down	20 Jul 1973
Launched	3 May 1977
Commissioned	11 Jul 1980

ILLUSTRIOUS (R 06)

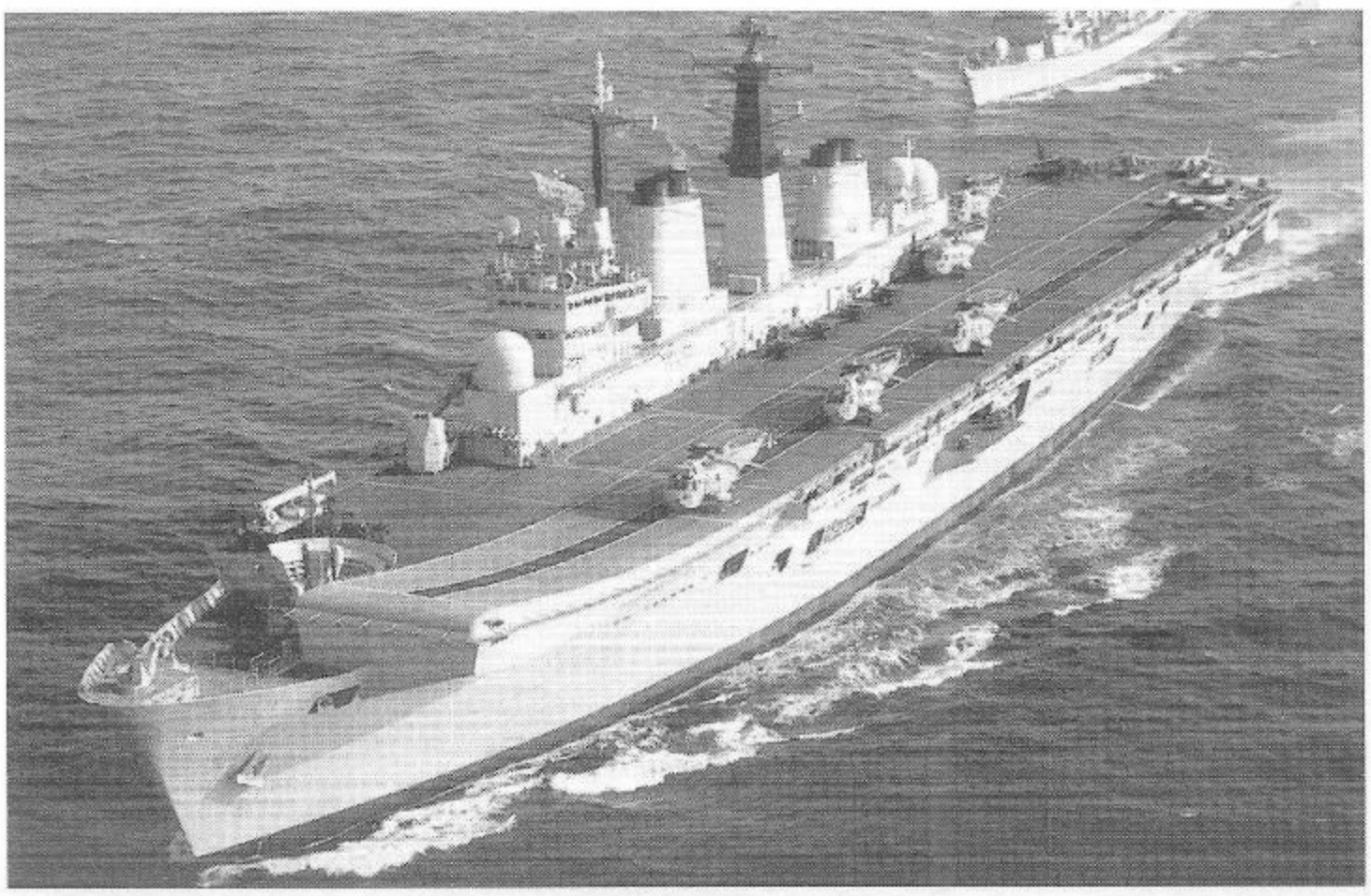
Builder	Swan Hunter Shipbuilders, Wallsend, UK
Laid down	7 Oct 1976
Launched	1 Dec 1978
Commissioned	20 Jun 1982
In reserve	May 1989-Aug 1991

ARK ROYAL (R 07)

Builder	Swan Hunter Shipbuilders, Wallsend, UK
Laid down	14 Dec 1978
Launched	2 Jun 1981
Commissioned	1 Nov 1985

Ark Royal *(R07); note the 20 mm Vulcan Phalanx CIWS in the bows and Sea Dart launcher on the forecastle. Among the antennas atop the bridge are a British SCOT satellite terminal (white radome to starboard) and a US WSC-1 satellite terminal (cylindrical antenna facing camera)*

Illustrious



Invincible *in 1995* (Jane's/H M Steele)

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

BAe Sea Dart

One British Aerospace Sea Dart twin-arm missile launcher with GWS.30 Mod 2 fire control system. The missile launcher is sited on the forecastle above a 22-round magazine. The semi-automatic fire-control system features a Ferranti data handling system with two FM1600 computers, and Marconi Underwater Systems Ltd (formerly Plessey) display systems. The system evaluates target priorities, assigns a tracker and, after the missile has been launched, issues guidance commands.

The system has scored some notable successes. Published sources, using data correlated from both sides, suggest that during the Falklands (Malvinas) war in 1982 the system destroyed seven aircraft definitely with another 'possible'. Similarly, during the Gulf War one of two Sea Darts fired by HMS *Gloucester* succeeded in destroying an incoming Styx-type anti-ship missile. The system also has a limited anti-ship capability.

Specifications

Length: 4.36 m (14.30 ft)
Diameter: 42 cm (16.53 in)
Wing span: 91 cm (35.82 in)
Weight: 550 kg (1,212 lb)
Speed: Mach 3.5
Range: 21.5 n miles (40 km)
Altitude: 100-18,500 m (330-60,700 ft)
Guidance: Semi-active radar

GUNS

Hughes Mk 15 CIWS Phalanx

Ark Royal (R 07 only). Three Hughes Mk 15 Phalanx close in weapons systems (CIWS). The Mk 15 CIWS is a 'closed-loop' weapon system designed to provide the innermost layer of defence against anti-ship missiles. The gun assembly is suspended between the supports of the mount and train drive assembly. It consists of a 20 mm M61A1 Vulcan Gatling-principle gun in an open box assembly with a cylindrical magazine and feeding mechanism suspended beneath. The M61A1 Vulcan consists of six 1.52 m (4.98 ft) long barrels, mounted at 60° to each other and powered by an electric drive. The Lockheed Electronics AN/UPS-2 radar is a 12 to 18 GHz (J-band) pulse Doppler sensor with a vertical tracking antenna at the front and a search antenna at the top. The shared transmitter, the receiver and servo mechanisms are all in the same housing. The system is capable of search, detection, threat evaluation, acquisition, track and fire modes which can be conducted automatically through a digital computer with manual override. When the gun fires, the radar tracks the centroid of six outgoing projectiles, predicts their point of closest approach to the target and corrects the aim of the following bursts. This technique uses variable PRF with selected spectral frequency line tracking to measure the stream of projectiles' angular error. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be three seconds.

Specifications

Gun
Calibre: 20 mm
Barrel length: 53 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)

Mounting
Weight: 5.42 t (Block 0), 6.18 t (Block 1)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s
Power requirement: 440 V, 60 Hz, 3 phase; 18 kW search, 70 kW transient

Manufacturer/Contractor

Hughes Missile Systems, Tucson, Arizona, USA

Signaal/General Electric 30 mm Goalkeeper

Invincible (R 05) and *Illustrious* (R 06) only. Three Signaal/General Electric 30 mm seven-barrelled Gatling Goalkeeper close in weapons systems. Goalkeeper is an autonomous, fully automatic system, consisting of a General Electric Sea Vulcan 30 gun, I-band search radar, I/K-band tracking radar, TV camera, and ancilliaries. The Sea Vulcan 30 is based upon the electro-hydraulically powered GAU-8/A 30 mm seven-barrel, Gatling gun, with each barrel firing only once during each revolution of the barrel cluster. The gun is very reliable, with 33,000 mean rounds between stoppages. The mounting has an ammunition capacity of 1,190 rounds carried in a linkless system using a feed and storage drum, which is claimed to be sufficient for several target engagements before reloading is necessary. The warhead kill capability of Goalkeeper against anti-ship missiles is achieved by use of MPDS rounds which have high-density, tungsten-alloy penetrators. For 'soft' targets, HEI and TP types of ammunition can be used.

The I-band search radar uses a 2,050 × 280 mm (80.3 × 11 in) linear array antenna with an integrated sidelobe suppression antenna. The antenna rotates at 60 rpm and has a horizontal beamwidth of 1.7° and a vertical beam-width of 60°. The radar is powered by a water-cooled, synthesiser-driven, TWT transmitter with high-output power for greater frequency and PRF flexibility in the face of ECM threats.

Specifications

Calibre: 30 mm
Muzzle velocity: 1,020 m/s (3,346.6 ft/s) (TP, HEI); 1,150 m/s (3,773.1 ft/s) (APDS)
Traverse: 360°
Elevation: −25 to +85°
Mounting weight: 6,800 kg (14,994 lb)
Crew: 0
Range: 200 m to 3 km (1.61 n miles)
Rate of fire: 4,200 rds/min
Ammunition: 369 g (TP, HEI, HEISD, API, MPDS)

Manufacturers/Contractors

Hollandse Signaalapparaten BV, Netherlands (system/radar).
General Electric Company, Armament Systems Department (gun).
NWM de Kruithoorn, 's-Hertogenbosch, Netherlands (MPDS ammunition).

Oerlikon/BMARC 20 mm GAM-BO1 cannon

Two Oerlikon/BMARC 20 mm GAM-BO1 mounts with single Oerlikon 20 mm 85-calibre, KAA cannon. These two single mounts are sited either side of the bridge superstructure.

Specifications

Calibre: 85
Muzzle velocity: 1,050-1,150 m/s (3,450-3,773 ft/s)
Effective range:
surface targets: 2.5 km (2,734 yd)
fixed-wing aircraft: 1,200 m (1,300 yd)
helicopters: 2,000 m (2,187 yd)
Rate of fire: 1,000 rds/min
Weight of projectile: 110-125 g
Weight of round: 320-345 g

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

UAA(2)

Ark Royal (R 07) only. UAA(2) is a passive reception, signal analysis and direction-finding part of the system and uses IFM receivers. Frequency range has not been released but is almost certainly 1 to 18 GHz. The intercept and DF antenna is a series of radome-covered horns normally mounted under the masthead radar. Accuracy of measurement is reported to be 1.5 MHz in frequency and 3° in bearing. UAA(2) was developed from UAA(1) and features solid-state electronics in its front end, an improved threat library and an increase in the number of warner channels.

Manufacturer/Contractor

Racal-Thorn Defence, Crawley, UK.

Invincible *replenishes from New Zealand AOR,* Endeavour, *in company with 'Leander' class frigate,* Waikato *(F 55)* (RNZN)

UAF (1)

Illustrious (R 06). The UAF(1) automated ESM system measures the parameters of received radar signals and compares them with a preprogrammed library of parameters. Signal identity, bearing and threat category are displayed in tabular format. Raw data on bearing and frequency are given on a display which can be overlaid with symbols and data derived from the signal analysis processor. Specific intercepts can be analysed in greater depth using a manual pulse analyser.

Manufacturer/Contractor

Racal, Racal Radar Defence Systems, UK.

ELECTRONIC COUNTERMEASURES (ECM)

Type 675(2)

Type 675(2) (Guardian) is an active and passive EW system designed to meet a wide range of operational requirements against threats, particularly those of radar-guided missiles. The system is designed to counter and confuse surveillance and missile homing radars by the use of selective jamming techniques for both area and point defence. Coverage is 360° in azimuth and 50° in elevation, with a detection range of up to 500 km. Type 675(2) has two antenna mounts to ensure uninterrupted all-round view, which can be installed

either port and starboard, or forward and aft. Each antenna mount carries a direction-finding receiving antenna together with transmit antennas, using mechanical steering to give full azimuth and elevation coverage. Received signals are passed from the antenna to a wideband receiver, where they are analysed to indicate those representing a threat, which are then processed to allow generation of the jamming signal. High-power transmitter subsystems, matched to the antenna, provide jamming capability against several types of target simultaneously. A comprehensive ECM library stores the appropriate countermeasures to a range of potential threats, and on receipt of a warning from the ESM system the ECM processor selects the appropriate jamming mode to give fast response. A contract is about to be let for an upgrade.

Manufacturer/Contractor
Racal-Thorn Defence, Crawley, UK.

OUTFIT DLJ(1)
Outfit DLJ(1) is a long-range chaff/infra-red decoy launching system, comprising four DLB (NATO Sea Gnat) and four DLD (SRBOC) six-barrelled launchers. The control unit provides for the launching of the most effective combination of rounds for distraction and centroid/seduction giving the type, speed and direction of the threat, the ship's speed and heading as well as wind direction and speed. Current munitions are the Mk 214 RF seduction and Mk 216 RF distraction and Mk 245 IR seduction rounds.

Manufacturers/Contractors
Racal-Thorn Defence/AB Precision Ltd, UK (control unit).
Hunting Engineering, UK (launcher).
Chemring Ltd, UK (Mk 214 chaff munition).
Royal Ordnance (Mk 216 chaff munition).

Noise suppression
Prairie Masker.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

ADAWS
The three carriers were completed with different versions of the British ADAWS (Action Data Automation Weapon Systems) (*Invincible, Illustrious* ADAWS 6 (Outfit DAF) and *Ark Royal* — ADAWS 10 (Outfit DAJ)), but the first two were subsequently upgraded to ADAWS 10. *Invincible* and *Ark Royal* are currently fitted with ADAWS 12 (ADAWS 10 hardware running Edition 12 software), while *Illustrious* has ADIMP (ADAWS Improvement Programme), as will the other two in due course.

ADAWS creates a detailed picture of the air, surface and subsurface tactical situation around a task group/task force and directs responses to threats. The system is based on two Ferranti FM1600 24-bit computers, using Coral 66 language software produced by the Defence Research Agency and Ferranti. Each has a 262 k maximum memory and an operating speed of 100 Kops. ADAWS accepts data from both on- and offboard sensors (the latter via Link 11 and a DataLink Pre-Processor (DLPP)), processes them and then drives the displays. The threats posed by different targets are assessed and they are then designated to the most appropriate weapon system. ADAWS also controls the ship's weapons, providing aiming and ballistic calculation data for the missiles and is also used to calculate data for controlling the operational use of both ASW helicopters and fighters.

ADIMP uses a Combat Systems Highway (CSH), together with VME and Motorola 68000-series microprocessors. The FM1600 processors are replaced by two F2420 processors each with 3 MBytes of memory and capable of 3.8 Mips. The display systems have been upgraded and the upgrade also involves supplying further peripheral systems. ADIMP will also have an Electronic Warfare Control Processor (EWCP), a knowledge-based system which integrates electronic warfare hard kill/soft kill elements such as Sea Gnat. Integrated with ADIMP is the Captain's Combat Aid (CCA), which contains embedded tactical doctrine and data on both the ship's performance and that of its weapon systems. Using sensor data acquired through the CSH this recommends the optimum course in multithreat scenarios.

Manufacturers/Contractors
GEC-Marconi S3I (Combat Systems Division).

COMMUNICATIONS AND DATALINKS

These carriers are fitted with a comprehensive range of communications facilities to cover their roles as task force/group Flagships in operations ranging from ASW, through amphibious warfare to long-range air strike. These facilities include HF, VHF and UHF radio communications, amongst which are:

Link 10
Link 11
Link 14
Link 16 (in due course)
JMCIS
Matra-Marconi SCOT 2C (R 05) or 2D (R 06, R 07 after next refit) Satcom
MARISAT.

RADARS

Type	Type 1022	Type 992R	Type 996(2)	Type 1006	Type 1007	Type 909	Type 909(I)
Fitted in	all	R 07	R 05/R 06	R 05/R 07	R 06	R 05/R 07	R 06
Maker	GEC-Marconi/Signaal	GEC-Marconi	Siemens-Plessey	Kelvin Hughes	Kelvin Hughes	GEC-Marconi	GEC-Marconi
Role	Long-range air search	Surface search	Surface search	Navigation	Navigation	Fire control (Sea Dart)	Fire control (Sea Dart)
Band	D	E/F	E/F	I	I	I/J	I/J
Beam	2.2 × csc² to 40°	1.25 × 15°	1.4 × 1.5°	1 × 18°/0.75 × 18°	1.0 × 18°/0.75 × 18°		
Peak Power	5.2 kW (mean)	3 MW	125 kW	25 kW	25 kW		
Gain	30 dB	30 dB	41 dB	31 dB/34 dB	31 dB/34 dB		
Pulsewidth	35/69 µs	2.0 µs	low angle — 65 µs; high angle — 31.5 µs	0.8 or 0.25 µs/0.75 µs	0.08/0.3/0.8 µs		
PRF	1,000/5,000 pps	750 pps	550-3,000 µs	1,600/800 pps	1,600/800/400 pps		
Scan rate	7.5/15 rpm			24 rpm	26 rpm		
Typical range	145 n miles (265 km)	80-90 n miles (148-167 km)		64 n miles (118.4 km)			

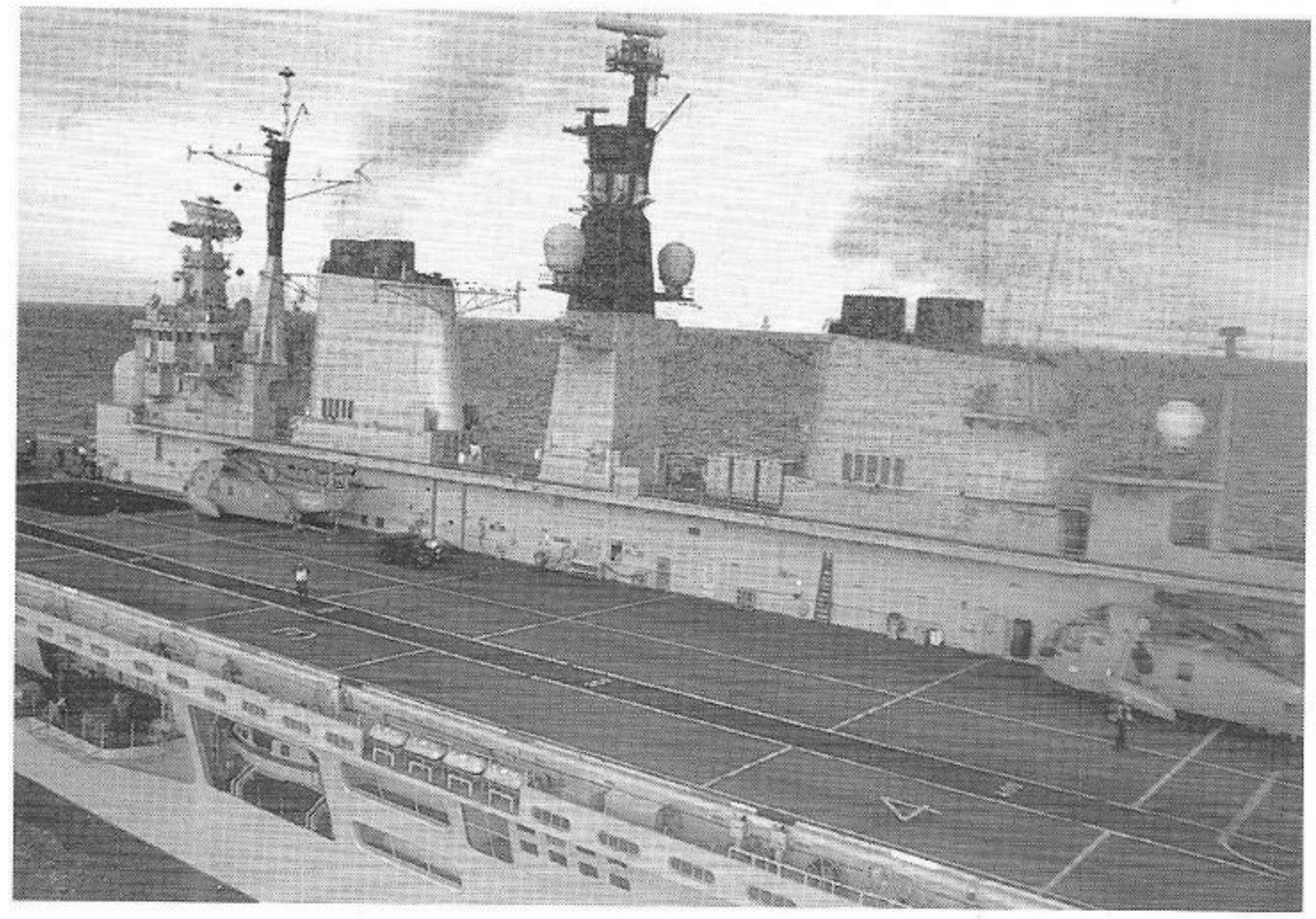
SONAR

Plessey Type 2016

The Plessey Type 2016, fitted in all three carriers, is a medium-frequency sonar, using a hull-mounted array, with two transmitters operating at 5.5, 6.5 and 7.5 kHz, with two modes: omnidirectional and steered directional.

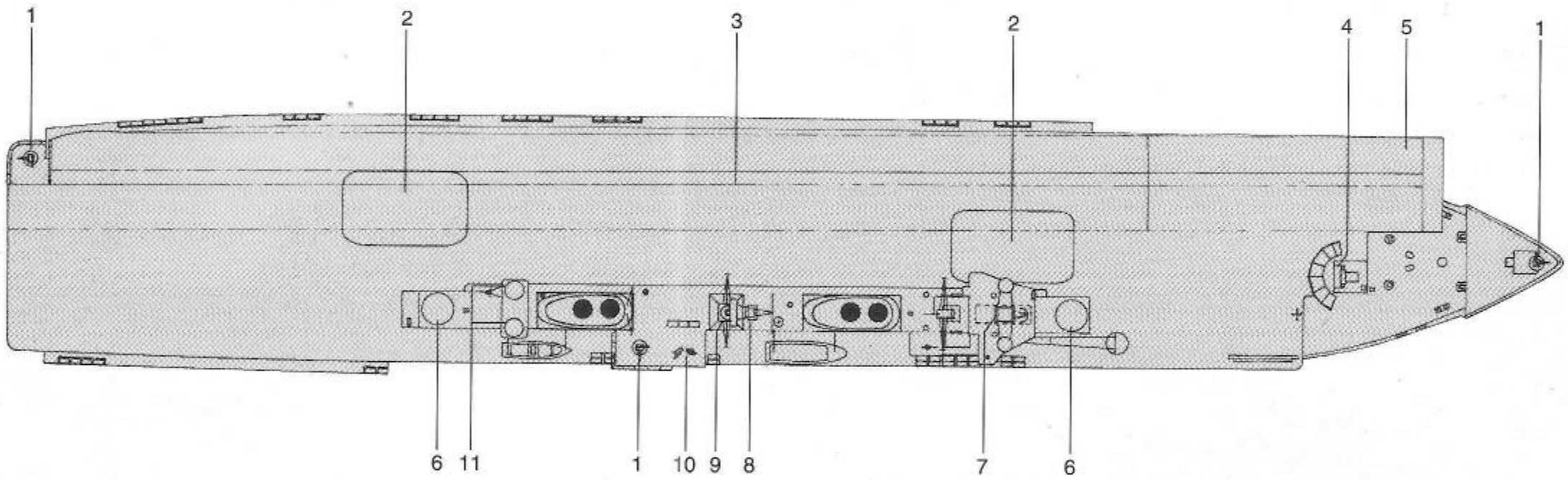
Manufacturers/Contractors

Thomson-Marconi Sonar, UK/France.



Illustrious *in November 1995 showing a variety of antennas. Forward of the bridge is the Type 909 Sea Dart control radar and atop the bridge the Type 1022 early warning radar. The foremast is topped by an Outfit AJK multichannel UHF antenna with, below it, the Kelvin Hughes Type 1007 antenna for the navigation radar. The mainmast (between the stacks) carries two SCOT satellite antennas with, immediately above them, the UAF intercept array, and at the top of the mast the Type 996 antenna. To the right of the after stack is a radome for an unknown system and, atop a short mast, a second Type 1007 antenna* (Jane's/H M Steele)

AVIATION



Invincible (Ian Sturton)
1 *Mk 15 20 mm Vulcan Phalanx CIWS* **2** *Elevators; 9.7 × 16.7 m (31.8 × 54.8 ft)* **3** *Flight deck; 167.8 × 13.5 m (550 × 44.3 ft)* **4** *BAe Sea Dart twin launcher* **5** *13° ski ramp* **6** *Type 909 radar* **7** *Marconi/Signaal Type 1022 air search radar* **8** *SCOT Satcom antennas (on either side of mast)* **9** *GAM-BO1 20 mm Oerlikon* **10** *Plessey Type 996 surface search radar* **11** *Outfit DLJ Sea Gnat dispenser*

AVIATION FACILITIES

Specifications

Flight deck: 167.8 × 13.5 m (550 × 44.3 ft)
Ski ramp: 12° (R 05, R 07); 13° (R 06)
Elevators: 2, each 9.7 × 16.7 m (31.8 × 54.8 ft) with an 8 m (26.25 ft) stroke

Air wing

(See Aircraft section for full details.)

FIXED-WING AIRCRAFT

BAe Sea Harrier FA 2

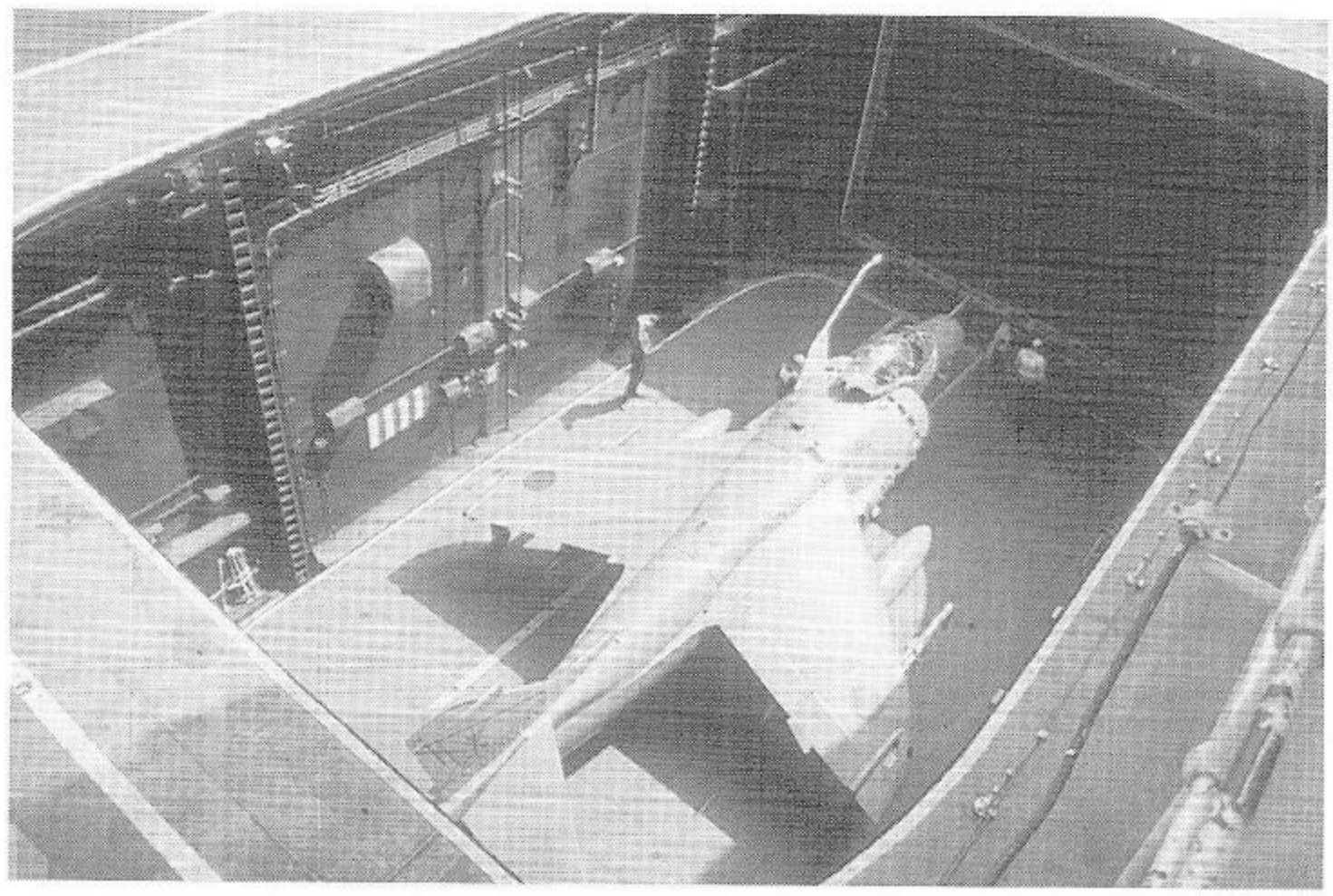
Six–eight BAe Sea Harrier FA 2.

Specifications

Wing span:
  normal: 7.70 m (25.25 ft)
  ferry: 9.04 m (29.66 ft)
Length:
  overall: 14.17 m (46.5 ft)
  nose folded: 13.16 m (43.17 ft)
Height: 3.71 m (12.17 ft)
Operating weight, empty: 6,374 kg (14,052 lb)
Max take-off weight: 11,880 kg (26,200 lb)
Max fuel:
  internal: 2,295 kg (5,060 lb)
  external: 2,404 kg (5,300 lb)
Max weapon load: 3,630 kg (8,000 lb)
Max speed, high altitude: 716 kts (1,328 km/h)
Max level speed, low altitude: 640+ kts (1,185 km/h)
Cruising speed, high altitude: Mach 0.8+
Attack radius: 250 n miles (463 km; 288 miles)
Engine: One Rolls-Royce Pegasus Mk 104 (95.6 kN; 21,500 lb st)
Accommodation: 1 (pilot only, on Martin-Baker Mk 10H zero/zero rocket ejection seat)
Weapons: 30 mm guns, 1,000 lb bombs, rockets and flares of UK and US designs, Sea Eagle ASM (2), AIM-9M Sidewinder, AIM-120B AMRAAM.

Manufacturer/Contractor

British Aerospace.



Harrier on aircraft lift in Invincible

November 1995 view of Illustrious, *with Sea Harrier FA 2s and Sea King helicopters. A Goalkeeper CIWS is on the sponson. At the after end of the superstructure is a Type 909(1) radar, which is part of the Sea Dart fire-control system, and below is the cylindrical antenna of WSC-1 satellite antenna* (Jane's/H M Steele)

HELICOPTERS

Westland Sea King HAS 6

A maximum of nine Westland Sea King HAS 6 multi-place ASW helicopters.

Specifications

Fuselage length: 17.02 m (55.83 ft)
Overall length, rotors turning: 22.15 m (72.66 ft)
Main rotor diameter: 18.90 m (62.0 ft)
Height, overall, rotors turning: 5.13 m (16.83 ft)
Area main rotor disc: 280.6 m² (3,020.3 sq ft)
Basic weight, incl sponsons: 5,447 kg (12,009 lb)
Weight empty, equipped (typical): 7,331 kg (16,163 lb)
Max T-O weight: 9,752 kg (21,500 lb)
Max speed, (never-exceed): 122 kts (226 km/h)
Cruising speed at S/L: 110 kts (204 km/h)
Max rate of climb at S/L: 564 m (1,850 ft)/min
Max vertical rate of climb at S/L: 246 m (808 ft)/min
Service ceiling: 1,220 m (4,000 ft)
Radius of action, 2 h on station, incl 3 torpedoes: 125 n miles (231 km; 144 miles)
Range with max standard fuel, at 1,830 m (6,000 ft): 800 n miles (1,482 km)
Sensors: GEC-Marconi 2069 dipping sonar and associated GEC-Marconi AQS-902G acoustic processing/display system; Racal Orange Reaper ESM; CAE Electronics AN/ASQ-504(V) internal MAD
Weapons: Mk 46, Whitehead A244S or Sting Ray homing torpedoes (4); or Mk 11 depth charges (4); 7.62 mm GPMG (1)
Engines: 2—1,238 kW (1,660 shp) Rolls-Royce Gnome H.1400-1T turboshafts. Total fuel capacity 3,714 litres (981 US gallons)

Manufacturer/Contractor

Westland Helicopters, Yeovil, Somerset, UK.

Westland Sea King AEW Mk 2A

Three Westland Sea King AEW Mk 2A AEW helicopters.

Specifications

Fuselage length: 17.02 m (55.83 ft)
Overall length, rotors turning: 22.15 m (72.66 ft)
Main rotor diameter: 18.90 m (62.0 ft)
Height, overall, rotors turning: 5.13 m (16.83 ft)
Area main rotor disc: 280.6 m² (3,020.3 sq ft)
Basic weight, incl sponsons: 5,447 kg (12,009 lb)
Weight empty, equipped (typical): 7,418 kg (16,353 lb)
Max T-O weight: 9,752 kg (21,500 lb)
Max speed, (never-exceed): 122 kts (226 km/h)
Cruising speed at optimum altitude: 90 kts (167 km/h)
Max rate of climb at S/L: 564 m (1,850 ft)/min
Max vertical rate of climb at S/L: 246 m (808 ft)/min
Service ceiling: 3,050 m (10,000 ft)
Radius of action, 2 h 24 min on station: 100 n miles (185 km)
Range with max standard fuel, at 1,830 m (6,000 ft): 800 n miles (1,482 km)
Sensors: Racal-Thorn Searchwater radar; Racal MIR-2 Orange Reaper ESM
Engines: 2—1,238 kW (1,660 shp) Rolls-Royce Gnome H.1400-1 turboshafts. Total fuel capacity 3,714 litres (981 US gallons)

PROPULSION

Specifications

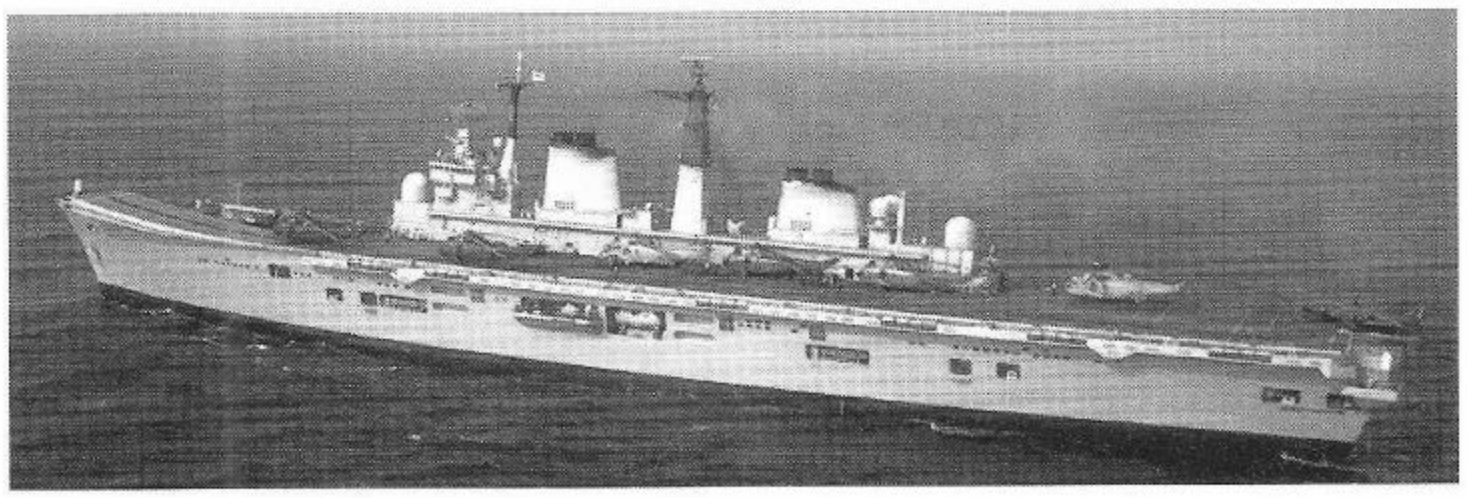
System: COGAG (COmbined Gas And Gas)
Main machinery: 4 Rolls-Royce Olympus TM3B gas turbines
Power output: 72.5 MW (97,200 shp) sustained; 83.53 MW (112,000 shp) max
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The UK was one of the pioneers of carrier-borne aviation and operated a sizeable force of carriers during the Second World War and well into the Cold War. The numbers gradually dwindled, however, until in February 1966 the government decided not to proceed with a new 50,000 tonne carrier, *Queen Elizabeth* (CVA-01) and only to retain a carrier force until 1971. In the event, the old *Ark Royal* survived in service until the end of the 1970s, by which time the "escort cruiser" programme had been enlarged into a "through-deck cruiser", capable in the first instance of operating six Sea King helicopters.

At first, the design was similar to that of the British 'Tiger' class, French Jeanne d'Arc, Italian Andrea Doria and the (then) Soviet Moskva, with a missile/gun armament on the foredeck, a large, conventional, central superstructure, and aviation facilities confined to a large after flight deck and an above-deck hangar. The British then decided to move the superstructure to the starboard side, thus enabling the flight deck to be continued forward to the bow, which gave rise to the new term 'through-deck cruiser'. Concurrently — and extremely fortunately — the Harrier V/STOL design was reaching maturity and by the early 1970s the RN was able to go firm on a ship displacing 19,500 tonnes with an air wing of five Sea Harriers and nine Sea Kings. The first of class, *Invincible,* was launched in 1973 and entered service in 1980. Also at that time the 'ski jump'



Ark Royal (Jane's/H M Steele)

was being perfected, in which a small ramp at the forward end of the flight deck enabled the Sea Harrier to take off with an additional 680 kg (1,500 lb) payload.

The V/STOL carrier concept was very quickly put to the test in actual combat, when, in 1982, *Invincible* was despatched to the South Atlantic, accompanied by the elderly carrier *Hermes,* which had been converted from a light fleet carrier to the V/STOL role (see *Vikrant* above). There is no doubt that without the aircraft carried by these two carriers the British could not have retaken the Falkland Islands (or, at least, not in the way they did), although shortcomings were shown in the lack of an AEW capability, and the need for shipboard close in defence. These problems have since been overcome by the development of the AEW Sea King and the installation of Vulcan/Phalanx or Goalkeeper CIWS on all three 'Invincible'-class carriers.

One of many lessons of the Falklands (Malvinas) War was the invaluable role played by naval air power and a pre-Falklands war plan to sell *Invincible* to Australia was quietly shelved.

MODERNISATION

These ships are in an almost constant state of modernisation, their normal operating cycle being that one is

always fully operational; a second is at short notice for active service (nominally, 31 days); and the third is either in reserve, or refit and could be made operational fairly quickly in the event of a crisis. The ship in refit is, however, very substantially modernised, a process that takes some two to three years:

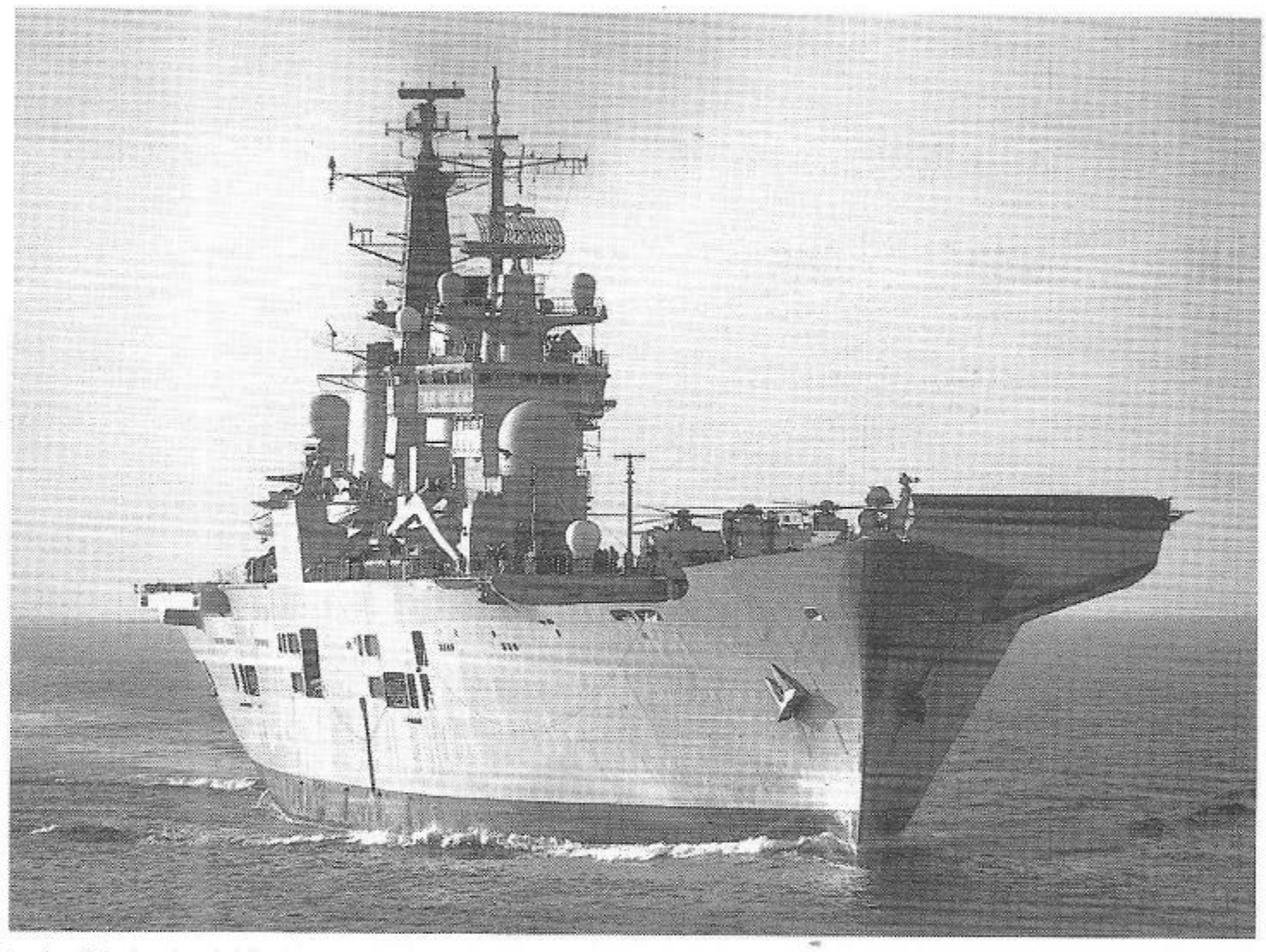
Invincible — Apr 1986-Jan 1989
Illustrious — Aug 1991-Apr 1994
Ark Royal — 1998-2000

Invincible's (R 05) 1986-89 modernisation included: fitting a 12° ski ramp; revamping space and support facilities to enable the ship to operate at least 21 aircraft (Sea Harriers, Sea King AEW and ASW helicopters); and the installation of three new Goalkeeper CIWS, and new sensors (Type 2016 sonar, Sea Gnat decoys and Type 996 radar). In addition, accommodation space was adjusted to enable an additional 120 aircrew and Flag Staff to be accommodated, while the Flag and Command facilities were upgraded to the same standard as the last ship to be completed (*Ark Royal* (R 07)).

Illustrious (R 06) underwent a similar modernisation in 1991 to 1994, bringing it to the same standard, but with yet further improvements to the command and weapon systems. In addition, a new main mast was fitted, as were new sponsons for chaff launchers, while the starboard side of the forecastle was roofed over to provide more aircraft parking space on the flight deck and an aircrew briefing-room immediately underneath. In addition, the ski ramp angle was increased to 13°, thus adding a small increment to aircraft payload. Plans to fit four lightweight Seawolf launchers were, however, cancelled as an economy measure.

Over the years, the two flight deck elevators have given some problems, since, in order to economise on space in the hangars, these devices have no vertical supports, being raised and lowered by two rising yokes on sloping cams. This arrangement has, however, proved less than totally successful, since the levelling mechanism has occasionally failed under load, allowing the platform to tilt about its longitudinal axis. This has led to damage to the aircraft on the elevator at the time and has subsequently reduced the carrier's operational effectiveness, since all aircraft transfers must then take place on one lift until the damage has been repaired. New elevators have, however, been designed by Strachan & Henshaw, using the scissor principle, with the outer leg of each scissor arm being anchored, while the inner leg travels along a track, with eight hydraulic rams acting through cams on the axle of each scissor. These have an identical footprint to the earlier elevators and will be among the many modifications fitted into *Ark Royal* (R 07) during its modernisation, which starts in 1997, and will, presumably, be eventually fitted in the other two ships, as well.

Illustrious *in November 1995, following a 30-month refit. The ski ramp is now at 13°, the highest angle yet achieved* (Jane's/H M Steele)



Invincible *in the Adriatic, supporting British forces in the former Yugoslavia* (Jane's/H M Steele)

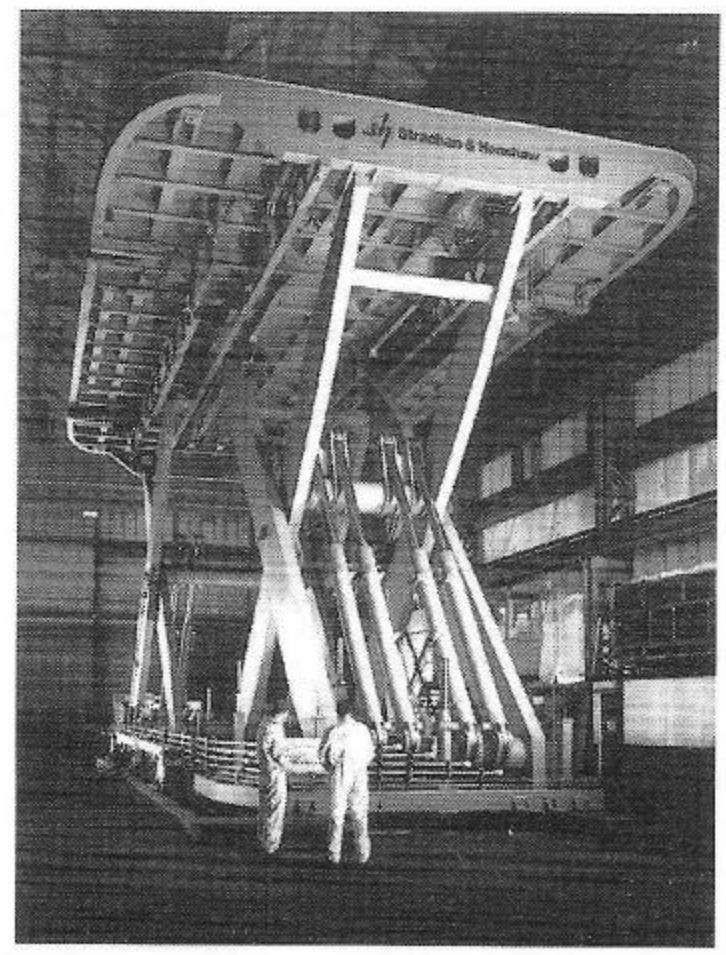
DESIGN

The fundamental feature of the design is the long, unobstructed flight deck, which provides excellent facilities for the ship's air wing of V/STOL fighters and helicopters. The flight deck is offset slightly to port, without detriment to flying operations, in order that the Sea Dart missile launcher can be located virtually amidships on the open forecastle head. The superstructure, which is offset to starboard as in conventional carriers, houses the flag, command and air bridges together with extensive command, control and communications facilities.

OPERATIONAL

The original role of this class was to provide a command, control and communications facility for British/NATO ASW task groups operating in the Greenland-Iceland-UK (GIUK) gap, while concurrently serving as a platform for both helicopters and STOVL aircraft. The carriers met this requirement well, but, in the Falklands (Malvinas) war and since the end of the Cold War, they have been developed into small-scale, but very useful power projection assets.

One of their many capabilities was well demonstrated during the Falklands (Malvinas) war when four RAF Harrier GR3 ground-attack aircraft flew from Ascension Island and, after several air-to-air refuellings, landed aboard the British carriers. This ferry flight of 6,400 km (4,000 n miles), conducted entirely across open ocean in single-engine aircraft, was a striking illustration of the combined capability of STOVL aircraft and this type of carrier. This concept is now being taken further in the late 1990s, when the emphasis is now on rapid deployment operations, and trials took place in 1994 in which three RAF Harrier GR7s spent two weeks aboard *Illustrious* (R 06). Despite the many differences between the GR7 and the navy's Sea Harrier — the former has a wing span of 9.24 m (30.3 ft) compared to the latter's 7.7 m (25.3 ft), for example — the trial was a success and showed that a future British seaborne rapid deployment force could add a genuine ground-attack capability to its many other advantages.



The new scissors elevator. The outer leg of each scissor is anchored, while the inner arm travels along a track. The platform is raised and lowered by eight hydraulic rams acting on an eccentric cam on the axle of each scissor (Strachan & Henshaw)

UNITED STATES AIRCRAFT CARRIERS

THE FUTURE

The strategic and tactical utility of a US Navy supercarrier and its air wing are unique. Such carriers represent a concentration of mobile power which no other nation can challenge, while their ability to move anywhere in the world in international waters provides a facility which no air force — limited by overflying rights and the need for foreign bases — can match. The capital costs of a US Navy supercarrier and its air wing, the running costs of the equipment and manpower and the scale of the logistic support required, are, however, simply enormous, and not only can no other nation afford such a programme but, within the USA itself, the costs are often challenged.

Thus, in the past the costs of nuclear-powered carriers were challenged in the mid-1960s, leading to the construction of two conventionally powered carriers when the navy had wanted nuclear-powered successors to the *Enterprise.* Similarly, in the 1970s planners examined concepts for small carriers using STOL aircraft and others for 'medium-sized' carriers using CTOL aircraft. More recently, the novel Mobile Offshore Base (MOB) has been proposed, which is intended to provide a logistic base for a force deployed at short notice into a foreign country. Also under examination is the CV(X), a study designed to establish the characteristics required of aircraft carriers to be funded in the years 1996-2001. Meanwhile, the current production programme continues, with CVN-75 due to join the fleet in 1998, followed by CVN-76 in 2002 and CVN-77 in 2009.

Service Life Extension Program (SLEP)

In 1979 the US Navy started a process known as the Service Life Extension Program (SLEP), which was, in essence, a particularly lengthy and thorough mid-life refit, and was aimed at extending the carriers' expected service life by an additional 15 years. This was achieved by producing a ship which would be both reliable and logistically supportable, and which would also be capable of operating all types of current and future fleet aircraft. Thus, while the major thrust of SLEP was repair and life enhancement, warfighting improvements were also incorporated to keep pace with the aircraft carrier modernisation baseline.

Each 2½ year SLEP included the overhaul of propulsion, auxiliary, and launch systems, together with extensive repairs to the structure of the ship, including tanks and pipes. Aircraft recovery equipment was upgraded and updated sensors, weapons systems, and electronic suites installed. On the earlier ships to undergo the SLEP programme this work also included installation of Vulcan Phalanx close in weapons system (CIWS), NATO Sea Sparrow surface-to-air missile system, SPS-49 radar, and the capability to handle F/A-18 Hornet aircraft.

In 1993, however, SLEPs ended and the system changed to the current procedure under which the carriers undergo 'extended overhauls,' in which they are modernised to current standards. Such work involves installing ACDS (the latest, improved version of NTDS), SPS-48E, TAS Mk 23 radar, new ASW systems and the Raytheon SLQ-32(V)4 combined EW intercept and jammer.

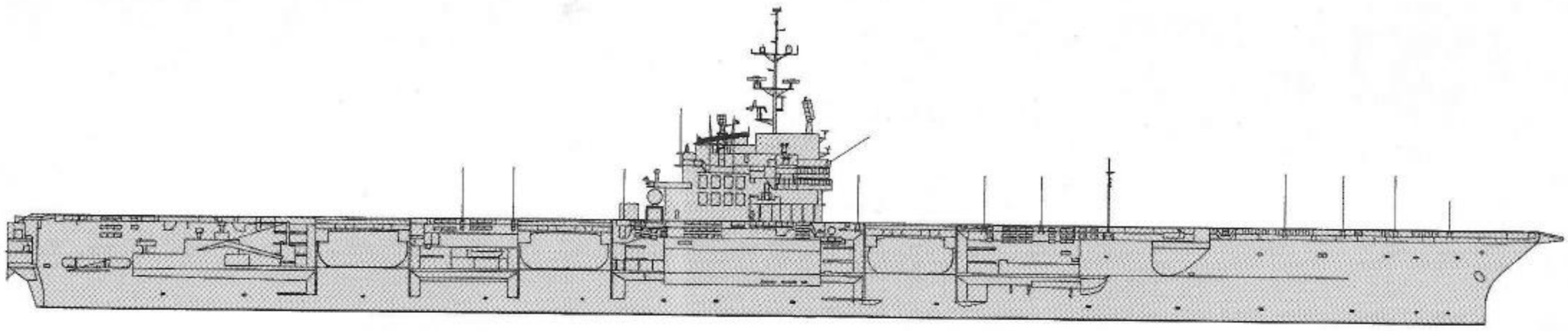
Air wings

There are two major changes to the policy regarding air wings. First, there are three basic types of air wing, as described below, but secondly, even with these new air wings, there is a much greater flexibility and a desire to produce the right combination of aircraft for a particular situation — known as 'adaptive force packaging'. Thus, US Army aircraft can be carried in place of naval aircraft, should the situation require it, as was done, for example, in the Haiti operation.

Air wing composition depends on the operational task, and carriers are deploying in one of three configurations, as shown in the table. The Transitional configuration totals 78 aircraft, while the Power Projection configuration adds four F/A-18s, bringing the total aboard to 82. The 50 TACAIR configuration, to which all air wings are expected to conform by FY97, reduces the number of F-14s to 14 and increases the number of F/A-18s to 36, to produce the 50 tactical aircraft which gives the package its name. Other elements in the new wing are two more S-3s, a reduction in the helicopter numbers to five, and final elimination of the A-6Es, for an overall total of 71 aircraft.

	Aircraft	Role	Transitional Air Wing	Power Projection Air Wing	50 TACAIR Air Wing
Fixed-wing	F-14	Interceptor/air superiority fighter	20	20	14
	F/A-18	Fighter-bomber	20	24	36
	A-6 E	All-weather bomber	16	16	0
	EA-6B	Electronic warfare	4	4	5
	E-2C	Airborne early warning	4	4	3
	S-3	Anti-submarine warfare	6	6	8
Helicopters	SH-60F/S-3	Anti-submarine warfare	8	8	3
	HH-60H	Combat search and rescue			2
Totals			78	82	71

FORRESTAL



Independence (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: USA
Type: Aircraft-carrier, conventional propulsion (CV)
Designation: SCB-80M

Class: FORRESTAL

Built: 4
Active: 1

Displacement:
standard: 60,000 t
full load: 80,643 t
Length: 326.4 m (1,071 ft)
Beam: 39.6 m (130 ft)
Draught: 11.3 m (37 ft)

Speed: 33 kts

Range: 8,000 n miles at 20 kts; 4,000 n miles at 30 kts

Complement:
ship's company: 2,900 (154 officers)
aircrew: 2,279 (329 officers)
Flag staff: 70 (25 officers)

SHIPS

FORRRESTAL (CV 59)

Builder	Newport News Shipbuilding, Newport News, Virginia, USA
Laid down	14 Jul 1952
Launched	11 Dec 1954
Commissioned	1 Oct 1955
Stricken	10 Sep 1993

SARATOGA (CV 60)

Builder	New York Naval Dockyard, New York, USA
Laid down	16 Dec 1952
Launched	8 Oct 1955
Commissioned	14 Apr 1956
Stricken	20 Aug 1994

RANGER (CV 61)

Builder	Newport News Shipbuilding, Newport News, Virginia, USA
Laid down	2 Aug 1954
Launched	29 Sep 1956
Commissioned	10 Aug 1957
To reserve	10 Jul 1993

INDEPENDENCE (CV 62)

Builder	New York Naval Dockyard, New York, USA
Laid down	1 Jul 1955
Launched	6 Jun 1958
Commissioned	10 Jan 1959

Forrestal *(CV60), nameship of the class, was the first US 'supercarrier', and introduced a totally new concept in mobile air power* (US DoD)

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Raytheon Mk 57 point-defence missile system

Independence is fitted with the Mk 57 NSSMS point-defence missile system which consists of three Mk 29, octuple launchers for the RIM-7 Sea Sparrow missile and three Mk 91 Mod 3 MFCS fire directors. The system is fully automatic from target acquisition to interception. The Seasparrow missile, although based upon the air-to-air Sparrow, has been enhanced for launching from ships, and has a 38.6 kg blast fragmentation warhead and a dual-purpose proximity-impact fuze.

Specifications

RIM-7M
Length: 3.66 m (12.0 ft)
Diameter: 20.3 cm (8.0 in)
Wing span: 1.02 m (3.35 ft)
Weight: 226.8 kg (500 lb)
Speed: Mach 2.5
Range: 8 n miles (14.5 km)
Warhead (WAU-17/B): 38.6 kg (85.1 lb)
Guidance: Semi-active radar

Manufacturers/Contractors

Raytheon Company, Equipment Division (prime system contractor).
Raytheon Company, Missile Systems Division (prime missile contractor).
Hughes Aircraft Company Missile Systems Group (second missile source).
Naval Weapons Center, Crane, USA (warhead).

GUNS

Hughes Mk 15 CIWS Phalanx

Three Hughes Mk 15 Phalanx close in weapons systems (CIWS) provide the innermost layer of defence against anti-ship missiles and consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be three seconds.

Specifications

Gun
Calibre: 20 mm
Barrel length: 53 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)

Mounting
Weight: 5.42 t (Block 0), 6.18 t (Block 1)

Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s
Power requirement: 440 V, 60 Hz, three phase; 18 kW search, 70 kW transient

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor
Hughes Missile Systems, Tucson, Arizona, USA (system).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

AN/SLQ-32(V)3

Independence is fitted with AN/SLQ-32(V)3 ECM system, which gives radar warning on B-J bands and jamming/deception on H-J bands. The (V)3 system covers Bands 1, 2 and 3. The jammer has a maximum radiated power of 1 MW and is capable of forming 64 beams on either side of the ship, with jamming modes including range gate pull off (RGPO) and azimuth gate pull off (AGPO).

Manufacturer/Contractor
Raytheon, Electromagnetic System Division, Goleta, California, USA.

ELECTRONIC COUNTERMEASURES (ECM)

AN/SLQ-25 Nixie noisemaker

One AN/SLQ-25 Nixie (Phase 1), a solid-state, modular design electro-acoustic countermeasures decoy system used to protect the carrier from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 487.5 m (1,599 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408.24 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 94.6 cm (3.1 ft) long, 15.24 cm (0.5 ft) in diameter and weigh 18.14 kg (90 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body at a time is deployed.

Manufacturer/Contractor
Aerojet ElectroSystems, Sacramento, California, USA.

DECOYS

Loral Hycor SRBOC

Four Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications
Launcher
Dimensions: 160 × 43 × 86 cm (5.2 × 1.4 × 2.8 in)
Weight: 173 kg (381.5 lb)
Range: 2.2 n miles (4 km)

Rounds
Mk 182: 1,209 × 130 mm; 22.7 kg
Super Chaffstar: 1,209 × 130 mm; 20.9 kg
Super Gemini: 451 × 130 mm; 5.5 kg
Super Hiram III: 1,220 × 130 mm; 13.6 kg
Super Hiram IV: 467 × 130 mm; 3.8 kg
Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturer/Contractor
Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Advanced Combat Direction System (ACDS)

The Advanced Combat Direction System (NTDS/ACDS) is an enhanced version of the Naval Tactical Data System (NTDS) tactical data handling and target designation system, which interfaces with the Mk 23 TAS. *Independence* has a Block 0 system with two AN/UYK-43B processors featuring software modules similar to those in the original NTDS, with a software package containing a database of approximately 1 million lines of code with an additional dedicated package specific to the host ship. The Block 0 system also features improvements in the Link 11 (TADIL A) interface, interfaces to new weapon and sensor systems as well as the replacement of the Hughes Video Signal Simulator (VSS) by the Republic Electronics AN/USQ-93 Radar Environmental Simulator System (RESS). Like NTDS, ACDS Block 0 provides Link 4A (TADIL C), Link 11 (TADIL A) and Link 14 communications.

Manufacturers/Contractors
Unisys, McLean, Virginia, USA (computers).
Hughes Aircraft Company, Los Angeles, California, USA (displays).
Rockwell International (Collins Avionics/Communications Division), Cedar Rapids, Indiana, USA (communications).

COMMUNICATIONS AND DATALINKS

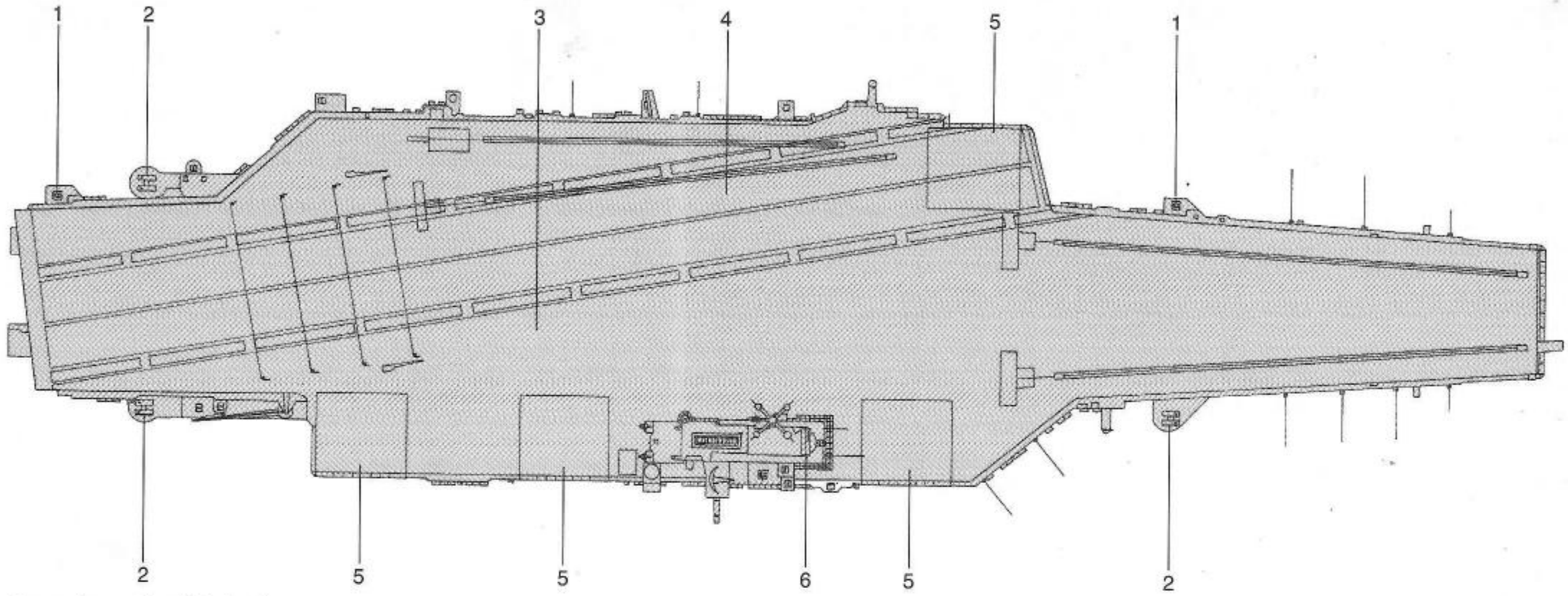
Independence is fitted with the normal range of radio equipment, including:
Datalinks: Link 4A (TADIL C); Link 11 (TADIL A); Link 14; Link 16 (TADIL J)
C^2 systems: JMCIS; JOTS; POST; CVIC
Communications satellite systems: SSQ-82; WSC-3 (UHF); WSC-6 (SHF); UESC-38 (EHF)
Threat simulation: UMM-1(V)1 TESS (Threat Emitter Simulation System)
Navigation satellite systems: SRN-9; SRN-19
TIROS-N: SMQ-11 (weather forecasting)
GPS: WRN-6.

RADARS

Type	SPS-48C	SPS-49(V)5	Target Acquisition System Mk 23	SPS-67(V)1	SPN 64(V)9	Mk 95 (four or six)
Maker	ITT-Gilfillan	Raytheon	Hughes	Westinghouse-Norden	Raytheon	
Role	Long-range air search; 3D	Long-range air search; 2D	Target acquisition for Sea Sparrow	Surface search	Navigation	Fire control (for Sea Sparrow SAM)*
Band	E/F	C/D	D	G	I	I/J
Beam	1.5 × 1.6°	3.4 × 30°csc²	3.3 × 75°	1.5 × 12°		
Peak power	2,200 kW	360 kW	200 kW	280 kW		2 kW
Gain	38.5 dB	28.5 dB	21 dB			
Pulsewidth	3 µs	125 µs		1/0.25/0.1 µs		
PRF	1,250-2,000 pps	280/800/1,000 pps	4,000/900 pps			
Scan rate	7.5/15 rpm	6/12 rpm	15/30 rpm	15 rpm		
Typical range	220 n miles; 30,000 m (100,000 ft)	250 n miles (457 km)	Surveillance - 90 n miles Engagement - 20 n miles	56 n miles (103.6 km)		

* Part of Mk 91 FCS

AVIATION



Independence (Ian Sturton)
1 *Vulcan Phalanx 20 mm CIWS* **2** *Raytheon GMLS Mk 29 octuple launcher for NATO Sea Sparrow* **3** *Flight deck; 319.1 × 82.3 m (1,047 × 270 ft)* **4** *Deck edge lift; 21.9 × 15.2 m (72 × 50 ft); 45 t capacity* **5** *Angled deck; 8°* **6** *SPS 48*

AVIATION FACILITIES

Specifications

Flight deck: 319.1 × 82.3 m (1,047 × 270 ft)
Angled deck: 8°
Elevators: 4 deck-edge 21.9 × 15.2 m (72 × 50 ft); capacity 44,900 kg (45 t)
Hangar: 240 × 7.6 m (787.4 × 24.7 ft)
Catapults: 4 Mk C 13 steam catapults
Arrester wires: 4
Aviation fuel: 5,500 t
Carrier-controlled approach radar suite: 1 SPN-41; J-band; microwave landing aid; 2 SPN-42; K-band; carrier-controlled approach; 1 ITT-Gilfillan SPN-43A; E-band; aircraft marshalling; 1 SPN- 44; F-band; microwave landing aid
Tacan: URN 25

Air wing
Independence is most likely to carry a 'Transitional Air Wing' which will comprise the following aircraft.

FIXED-WING AIRCRAFT

20 Grumman F-14D Tomcat

Specifications

Role: Fleet fighter aircraft for long-range air defence of task groups; undergoing phased improvements
Wing span:
min sweep: 19.54 m (64.08 ft)
max sweep: 11.65 m (38.21 ft)
Length: 19.1 m (62.75 ft)
Height: 4.88 m (16.0 ft)
Operating weight, empty: 18,950 kg (41,780 lb)
Max take-off weight: 33,724 kg (74,349 lb)
Max fuel (internal): 7,348 kg (16,200 lb)
Max weapon load: 6,577 kg (14,500 lb)
Max level speed, high altitude: 1,078 kts (1,997 km/h)
Combat radius (combat air patrol): 1,075 n miles (1,994 km)
Engine: 2 General Electric F110-GE-400 turbofans, each 62.27 kN (14,000 lb) dry; 102.75 kN (23,100 lb) with afterburning
Accommodation: 2
Sensors: APG-71 radar, ALQ-126 jammer, ASN-139, ALR-67 RWR; IRST and JTIDS (Link 16)
Weapons:
air defence: 1 × 20 mm cannon, 6 × AIM-54 Phoenix; AGM-88 HARM and AGM-84 Harpoon/SLAM being added
combat air patrol (CA): 1 × 20 mm cannon, 4 × Phoenix, 2 × AIM-7M, 2 × AIM-9M
reconnaissance: 1 × 20 mm cannon, 2 × AIM-7M, 2 × AIM-9M

20 McDonnell Douglas F/A-18C Hornet

Specifications

Role: Strike interdictor. Some are used for EW support with ALQ-167 jammers
Wing span: 11.43 m (37.5 ft)
Length: 17.07 m (56.0 ft)
Height: 4.66 m (15.28 ft)
Operating weight, empty: 10,455 kg (23,050 lb)
Max take-off weight: 25,401 kg (50,000 lb) (approx)
Max internal fuel: 4,926 kg (10,860 lb)
Max weapon load: 7,031 kg (15,500 lb)
Max level speed, high altitude: 1,033+ kts (1,195 km/h)
Attack radius: 575 n miles (1,065 km) on attack mission
Engine: 2 General Electric F404-GE-402 turbofans, each rated at 78.73 kN (17,700 lb st) with afterburning
Accommodation: 1
Sensors:
ESM: ALR 67, ALQ 165 ASPJ jammer (18D), APG-65 or APG-73 radar, AAS-38 FLIR, ASQ-173 tracker
Weapons:
ASV: 4 × Harpoon or SLAM (18D) or AGM-88 HARM (18D) missiles
Typical weapon loads:
attack mission: up to 7.7 t of bombs
air defence: 1 × 20 mm Vulcan cannon, 9 × AIM-7/AIM-9 missiles
anti-ship strike: 20 mm gun, 7.7 t bombs, 2 AIM-9 missiles
suppression of enemy air defences (SEAD): 4 AGM-88 HARM or up to 26 ADM-141 decoy drones
general purpose: max of 22—227 kg (500 lb) Mk 82 or 10—454 kg (1,000 lb) Mk 83 iron bombs can be carried

16 Grumman A-6E Intruder

Specifications

Role: All-weather strike and armed reconnaissance aircraft. Updating programme cancelled in mid-1993 after 186 had been modified. All will be phased out by 1997, but with 100 being kept in reserve until 2000
Wing span: 16.15 m (53.0 ft)
Length: 16.69 m (54.66 ft)
Height: 4.93 m (16.17 ft)
Operating weight, empty: 15,525 kg (27,613 lb)
Max take-off weight: 26,580 kg (58,600 lb)
Max internal fuel: 7,230 kg (15,939 lb)
Max weapon load: 8,165 kg (18,000 lb)
Max level speed, low altitude: 560 kts (1,037 km/h)
Attack radius: 878 n miles (1,627 km)
Engines: 2 Pratt & Whitney J52-P-8B each rated at 41.37 kN (9,300 lb st) dry
Accommodation: 2
Sensors: APQ-156 search/attack radar, ALR 67 ESM, RWR, ECM
Weapons:
anti-ship: 2 AGM-84 Harpoon, plus iron bombs
precision attack: up to 8.2 t of underwing stores
self-defence: 4 × AIM-9 Sidewinder or 2 AIM-120 AMRAAM or 2 AIM-7M Sparrow

Four Grumman EA-6B Prowler

Specifications

Role: EW and jamming aircraft to accompany strikes and armed reconnaissance; uprated to ADVCAP standard with new engines and ECM
Wing span: 16.15 m (53.0 ft)
Length: 18.24 m (59.83 ft)
Height: 4.95 m (16.25 ft)
Operating weight, empty: 14,321 kg (31,572 lb)
Max take-off weight: 29,484 kg (65,000 lb)
Max fuel: 6,995 kg (15,422 lb)
Max level speed, low altitude: 566 kts (1,048 km/h)
Range: 955 n miles (1,769 km) (with max external load)
Engine: 2 Pratt & Whitney J52-P-408 each rated at 49.8 kN (11,200 lb st) dry
Accommodation: 4 (pilot, 3 ECM officers (ECMO))
Sensors: APS-130 radar; ALQ-99F, ALQ-149 (ADVCAP) jammers
Weapons: AGM-88 HARM anti-radiation missile capable

Four Grumman E-2C Hawkeye

Specifications

Role: Direction of air defence and strike operations
Wing span: 24.56 m (80.58 ft)
Length: 17.54 m (57.56 ft)
Height: 5.58 m (18.31 ft)
Operating weight, empty: 17,265 kg (38,063 lb)
Max take-off weight: 23,566 kg (51,933 lb)
Max fuel (internal): 5,624 kg (12,400 lb)
Max weapon load: Nil
Max level speed, low altitude: 323 kts (598 km/h)
Operational radius: 175 n miles (320 km) for 3-4 hour patrol
Engines: 2 Allison T56-A-425, each rated at 3,661 kW (4,910 ehp)
Accommodation: 5 (pilot, co-pilot, CIC officer, air control officer, radar operator)
Sensors: ALR-73 PDS; ALQ-108; airborne tactical data system with Links 4A and 11; APS-125/138/145 radar
Weapons: Unarmed

Six Lockheed S-3B/ES-3A Viking

Specifications

Role: Anti-submarine aircraft (usually in concert with towed array escorts) and anti-ship. Sixteen converted to

ELINT configuration (ES-3A) to replace obsolete EA-3B in combined EW and targeting roles
Wing span: 20.93 m (68.66 ft)
Length: 16.26 m (53.33 ft)
Height: 6.93 m (22.75 ft)
Operating weight, empty: 12,088 kg (26,650 lb)
Max take-off weight: 23,832 kg (52,540 lb)
Max internal fuel: 5,753 kg (12,863 lb)
Max weapon load: 3,175 kg (7,000 lb)
Max level speed, low altitude: 439 kts (814 km/h)
Attack radius: 945+ n miles (1,751+ km)
Engines: 2 General Electric TF34-GE-2 turbofans rated at 41.26 kN (9,275 lb st) each
Accommodation: 4 (pilot, co-pilot, tactical co-ordinator, sensor operator)
Sensors: APS-137(V)1 radar; APN-200 radar, FLIR, MAD, ASQ-81(V)1, 60 × sonobuoys; ESM: ALR-76; ECM ALE 47; ALE 39 chaff
Weapons:
ASW: 4 × Mk 54 depth charges, 4 × Mk 46/Mk 50 torpedoes
ASV: 2 × Harpoon Block 1C; mines

HELICOPTERS

Eight Sikorsky SH-60B/F Ocean Hawk

Specifications

Role: SH-60F Ocean Hawk is a carrierborne inner-zone ASW aircraft which is replacing the SH-3. It is derived from the SH-60B LAMPS III Seahawk, but has a completely different internal fit with all LAMPS III avionics, fairings and equipment removed, including cargo hook and RAST system main and tail probes, although installation provisions are retained. Secondary missions include search and rescue and plane guard
Rotor diameter: 16.36 m (53.75 ft)
Main rotor area: 210.05 m² (2,262.03 sq ft)
Length: 19.76 m (64.83 ft)
Height: 3.63 m (11.92 ft)
Operating weight, empty: 6,191 kg (13,648 lb)
Max take-off weight: 10,659 kg (23,500 lb)
Max fuel: 2,233 litres (590 US gallons)
Max level speed, low altitude: 126 kts (234 km/h)
Operating radius: 150 n miles (278 km) for 1 h loiter
Engine: 2 General Electric T700-GE-401 turboshafts, each rated at 1,260 kW (1,690 shp)
Accommodation: 3 (pilot, co-pilot/airborne tactical officer, sensor operator)
Sensors: Bendix AQS-13F dipping sonar (to be replaced by ALFS), MIL-STD-1553B databus, dual Teledyne Systems ASN-150 tactical navigation computers; Link 11
Weapons: 3 Mk 50 torpedoes

PROPULSION

Specifications

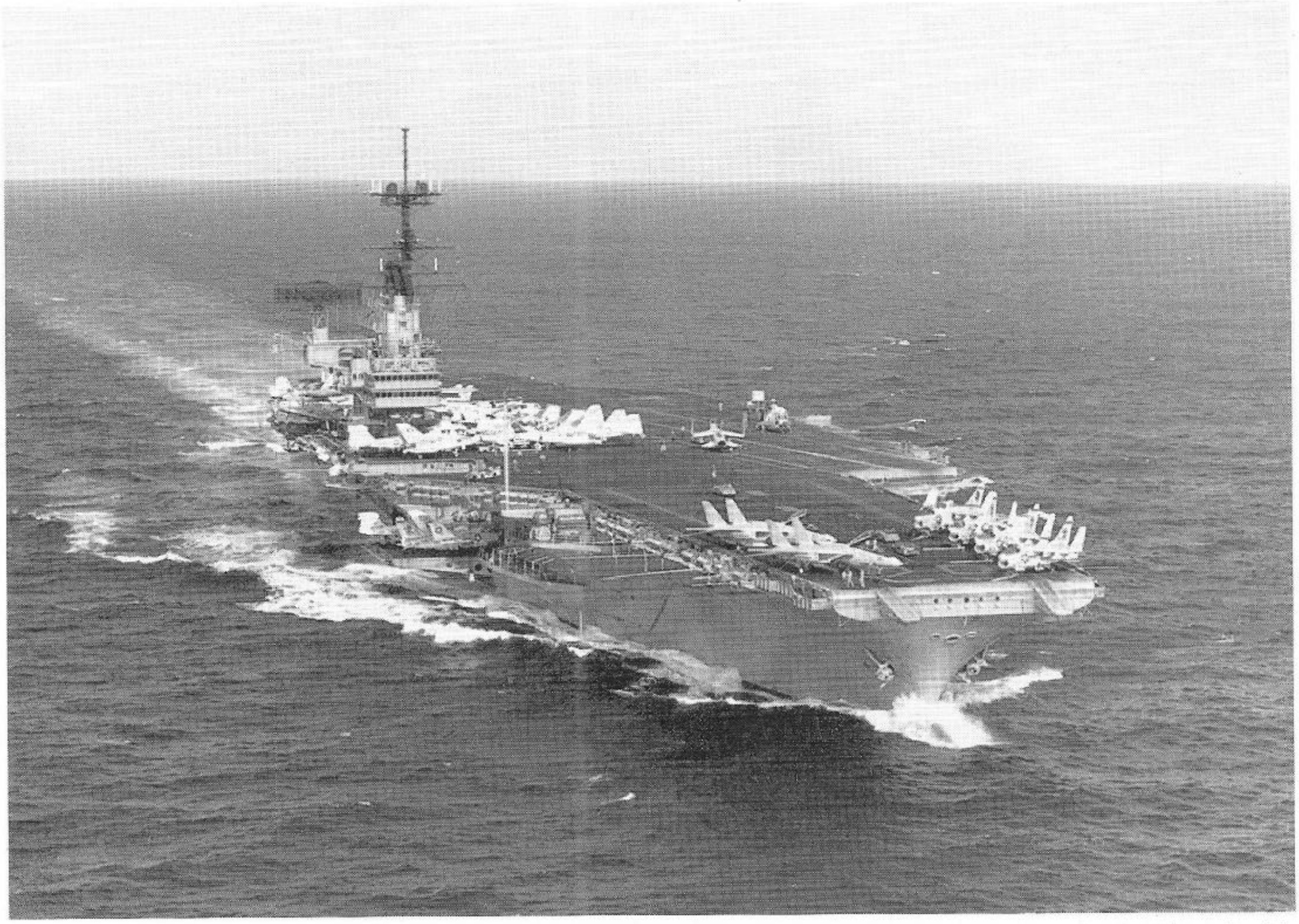
System: Steam
Boilers: 8 Babcock & Wilcox
Pressure: 83.4 kg/cm² (1,200 psi)
Working temperature: 510°C (950°F)
Turbines: 4 Westinghouse
Power output: 209 MW (280,000 hp)
Shafts: 4

FURTHER INFORMATION

PROGRAMME

There was a period of doubt concerning the role of seaborne air power in the years following the Second World War, but this was dispelled by two events. First, was the US Navy's perceived need for the ability to conduct nuclear strikes against strategic targets ashore, and secondly, the Korean War, which re-emphasised the tactical role of carrierborne aircraft against land targets. One of the basic design requirements for the new class of carriers was the need to accommodate and operate two disparate types of aircraft: the North American A-3 Savage, twin-turboprop nuclear bomber, which weighed some 35,455 kg (78,000 lb) and required a 7.62 m (25 ft) high hangar, while the other was the new generation of turbojet fighters then coming into service.

The result was the 'Forrestal' class, which was far larger than any other aircraft carriers built up to that time, and of a size, complexity and cost which no navy, other than that of the Unites States, is ever likely to be able to afford. They also set the general pattern for all



Independence *(CV 62) is now the only 'Forrestal' class carrier remaining in service and is due to pay off at the end of 1997, when it will be replaced by* Constellation *(CV64)* (US DoD)

Independence *(CV 62)* (Jane's/H M Steele)

subsequent American 'supercarrier' designs; indeed, the only change of any major significance in later designs is that some have nuclear, rather than conventional propulsion.

In the 'Forrestal' class, the flight deck became the strength deck, whereas in previous US Navy designs it had always been the hangar deck. Secondly, the British-designed angled deck had been successfully tested in the modified 'Essex' class carrier, *Antietam,* and the design of the *Forrestal* was amended during construction to incorporate this. Thirdly, only side elevators were used, thus doing away with the centreline design, making possible a long and uninterrupted hangar space, and greatly easing aircraft movements both on the flight deck and below in the hangar. Three of the elevators were on the starboard side (one forward of the superstructure and two abaft it), although the fourth, which was on the port side at the forward end of the angled deck, proved to be impossible to use during landing operations. Other features included steam catapults (also a British invention), an enclosed bow area to improve seaworthiness, an armoured flight deck, and advanced underwater protection and internal compartmentation to reduce effects of conventional and nuclear attack.

The four carriers were authorised in FY52 and joined the fleet between 1955 and 1959, setting totally new standards for sea-based air power.

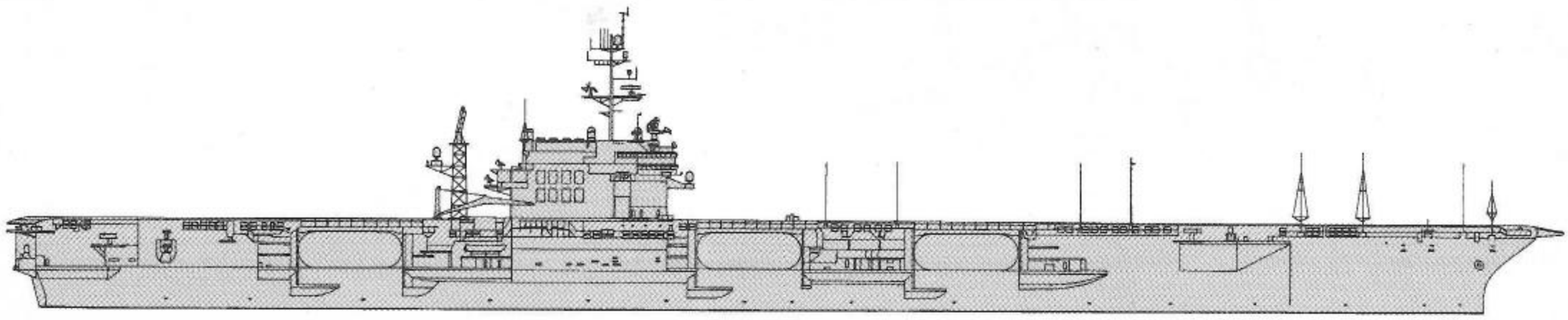
MODERNISATION

The four 'Forrestal' class carriers have undergone repeated modernisation and refit during their operational lives. Three underwent the Service Life Extension Programme (SLEP) during the 1980s (*Independence* (CV 62) from April 1985 to February 1988), but *Ranger* (CV 61) only received an extended overhaul in 1984-85. Two Mk 25 BPDMS launchers were fitted in 1973, with the consequent removal of all 127 mm (5 in) guns, but these BPDMS were subsequently replaced by three Mk 29 GMLS launchers during SLEP. Other SLEP measures included Kevlar armour over the most vulnerable areas, improved data systems, improved command facilities for the Flag officer and his staff, and better accommodation.

THE FUTURE

At one stage all these carriers were scheduled to serve well into the 21st Century, but it now appears that none will survive long enough to see the Millenium. Two have already paid off — *Forrestal* in 1993 and *Saratoga* in 1994 — while *Ranger* was placed in reserve in 1993. Thus only one of the class, *Independence,* remains in service. This ship was transferred from the Atlantic to the Pacific Fleet in 1988 and has been home-ported in Yokosuka, Japan, since 11 Sep 1991. *Independence* is scheduled to pay off in late 1997 when it will be relieved by the 'Kitty Hawk' class carrier, *Constellation* (CV-64).

KITTY HAWK/JOHN F KENNEDY



Kitty Hawk (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: USA
Type: Aircraft carrier, conventionally powered (CV)

Class: KITTY HAWK and JOHN F KENNEDY

Built: 4
Active: 4

Speed: 32 kts
Range: 4,000 n miles at 30 kts; 12,000 n miles at 20 kts

Displacement	CV 63	CV 64	CV 66	CV 67
standard	60,100 t	60,100 t	60,300 t	61,000 t
full load	81,123 t	81,773 t	79,724 t	80,941 t
Dimensions				
Length	323.6 m (1,062.5 ft)	326.9 m (1,072.5 ft)	319.3 m (1,047.5 ft)	320.6 m (1,052.0 ft)
Beam	39.6 m (130 ft)	39.6 m (130 ft)	39.6 m (130 ft)	39.6 m (130 ft)
Draught	11.4 m (37.4 ft)	11.4 m (37.4 ft)	11.4 m (37.4 ft)	11.4 m (37.4 ft)

Complement (typical):
ship's company: 2,930 (155 officers)
air group: 2,480 (320 officers)
Flag staff: 70 (25 officers)

SHIPS

KITTY HAWK (CV 63)
Builder New York Shipbuilding, New York, USA
Laid down 27 Dec 1956
Launched 21 May 1960
Commissioned 29 Apr 1961

CONSTELLATION (CV 64)
Builder New York Naval Shipyard, New York, USA
Laid down 14 Sep 1957
Launched 8 Oct 1960
Commissioned 27 Oct 1961

AMERICA (CV 66)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 9 Jan 1961
Launched 1 Feb 1964
Commissioned 23 Jan 1965

JOHN F KENNEDY (CV 67)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 22 Oct 1964
Launched 27 May 1967
Commissioned 7 Sep 1968

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Raytheon Mk 57 point-defence missile system

These ships are fitted with the Mk 57 NSSMS point-defence missile system, which consists of three Mk 29, octuple launchers for the RIM-7 Sea Sparrow missile and three Mk 91 Mod 3 MFCS fire directors. The system is fully automatic from target acquisition to interception. The Seasparrow missile, although based upon the air-to-air Sparrow, has been enhanced for launching from ships, and has a 38.6 kg (85.1 lb) blast fragmentation warhead and a dual-purpose proximity impact fuze.

Specifications
RIM-7M
Length: 3.66 m (12 ft)
Diameter: 20.3 cm (0.67 ft)
Wing span: 1.02 m (3.3 ft)
Weight: 226.8 kg (500 lb)
Speed: Mach 2.5
Range: 8 n miles (14.5 km)
Warhead (WAU-17/B): 38.6 kg (85.1 lb)
Guidance: Semi-active radar

Manufacturers/Contractors
Raytheon Company, Missile Systems Division, Bedford, Maine, USA (prime missile contractor).
Naval Weapons Center, Crane, USA (warhead).

GUNS

Hughes Mk 15 CIWS Phalanx

Three Hughes Mk 15 Phalanx close in weapons systems (CIWS). These weapons provide the innermost layer of defence against anti-ship missiles and consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling- principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be three seconds.

Specifications
Gun
Calibre: 20 mm
Barrel length: 53 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)

Mounting
Weight: 5.42 t (Block 0), 6.18 t (Block 1)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s
Power requirement: 440 V, 60 Hz, 3 phase; 18 kW search, 70 kW transient

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor
Hughes Missile Systems, Tucson, Arizona, USA.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

AN/SLQ-32(V)4

All four carriers have had their AN/SLQ-29 systems replaced by the AN/SLQ-32(V)4 ECM system, which is generally similar to SLQ-32(V)3, but with some extra facilities to cope with the size of the carriers, one being a fibre optic link between port and starboard units to handle data communications. The system gives radar warning on B-J bands and jamming/deception on H-J bands. The jammer has a maximum radiated power of 1 MW and is capable of forming 64 beams on either side of the ship, with jamming modes including range gate pull off (RGPO) and azimuth gate pull off (AGPO). The system is designed to give four levels of protection: first, warning, identification and directional information on radars associated with the targeting and launch of anti-ship missiles; and, second, jamming to prevent, or, at the least, to delay the launch of such missiles. If these measures fail, the system will give all the necessary information on any missiles that are actually launched; and, finally, it will deflect any such missiles in flight away from their intended target.

Manufacturer/Contractor
Raytheon, Electromagnetic System Division, Goleta, California, USA.

AN/SLQ-25 Nixie noisemaker

One AN/SLQ-25 Nixie (Phase 1), a solid-state, modular design electro-acoustic countermeasures decoy system used to protect the carrier from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 487.5 m (1,599 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408.24 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 94.6 cm (3.1 ft) long, 15.24 cm (0.5 ft) in diameter and weigh 18.14 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body is deployed at a time.

Manufacturer/Contractor

Aerojet ElectroSystems, Sacramento, California, USA.

DECOYS

Loral Hycor SRBOC

Four Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications

Launcher

Dimensions: 160 × 43 × 86 cm (5.2 × 1.4 × 2.8 in)
Weight: 173 kg (381.5 lb)
Range: 4 km (2.2 n miles)

Rounds

Mk 182: 1,209 × 130 mm; 22.7 kg
Super Chaffstar: 1,209 × 130 mm; 20.9 kg
Super Gemini: 451 × 130 mm; 5.5 kg
Super Hiram III: 1,220 × 130 mm; 13.6 kg
Super Hiram IV: 467 × 130 mm; 3.8 kg
Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturers/Contractors

Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

Surface Ship Torpedo Decoy System (SSTDS)

All four carriers were fitted with SLQ-36 Nixie in the late 1980s, but this is being progressively replaced by SSTDS.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Advanced Combat Direction System (ACDS)

The Advanced Combat Direction System (ACDS) is installed in all four carriers. This is an enhanced version of the Naval Tactical Data System (NTDS) tactical data handling and target designation system, which interfaces with the Mk 23 TAS. All four carriers currently have a Block 0 system with two AN/UYK-43B processors featuring software modules similar to those in the original NTDS, with a software package containing a database of approximately 1 million lines of code with an additional dedicated package specific to the host ship. The Block 0 system also features improvements in the Link 11 (TADIL A) interface, interfaces to new weapon and sensor systems as well as the replacement of the Hughes Video Signal Simulator (VSS) by the Republic Electronics AN/USQ-93 Radar Environmental Simulator System (RESS). Like NTDS, ACDS Block 0 provides Link 4A (TADIL C), Link 11 (TADIL A) and Link 14 communications. *Constellation,* currently in SLEP, is being fitted with ACDS Block 1 and will carry out trials on the system. All are to be converted by 1997.

Manufacturers/Contractors

Unisys, McLean, Virginia, USA (computers).
Hughes Aircraft Company, Los Angeles, California, USA (displays).
Rockwell International (Collins Avionics/Communications Division), Cedar Rapids, Indiana, USA (communications).

COMMUNICATIONS AND DATALINKS

These carriers have the full range of naval communications and datalink systems, including:

Datalinks: Link 4A (TADIL C); Link 11 (TADIL A); Link 14; Link 16 (TADIL J)
C^2 systems: JMCIS; JOTS; POST; CVIC
Communications satellite systems: SSQ-82; SRR-1; WSC-3 (UHF); WSC-6 (SHF); UESC-38 (EHF)
Threat simulation: UMM-1(V)1 TESS (Threat Emitter Simulation System)
Navigation satellite systems: SRN-9; SRN-19
TIROS-N: SMQ-11 (weather forecasting)
GPS: WRN-6

RADARS

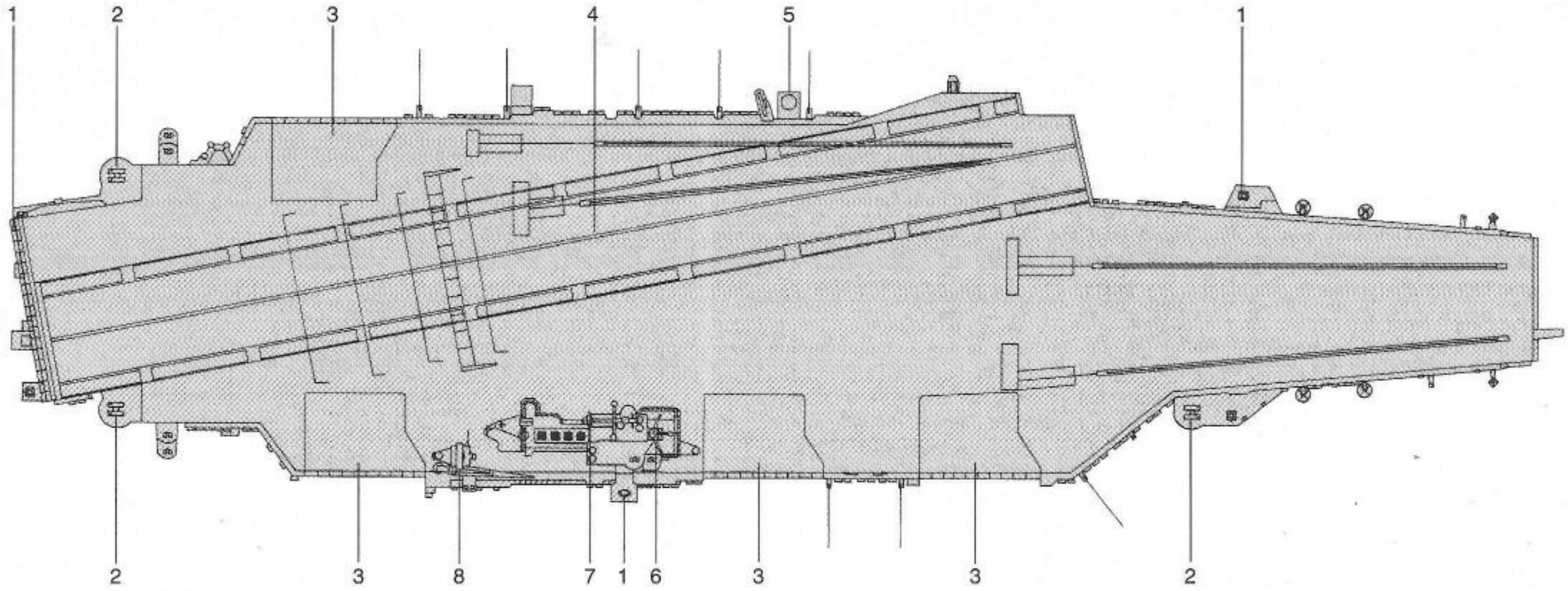
Type	SPS-48C/E	SPS-49(V)5	TAS Mk 23	SPS-67(V)1	SPN-64(V)9	904	Mk 95 (six)
Maker	ITT-Gilfillan	Raytheon	Hughes	Westinghouse-Norden	Raytheon	Furuno	
Role	Long-range air search; 3D	Long-range air search; 2D	Target acquisition for Sea Sparrow	Surface search	Navigation	Navigation	Fire control (for Sea Sparrow SAM)*
Band	E/F	C/D	D	G	I	H/I	I/J
Beam	1.5 × 1.6°	3.4 × 30° csc²	3./3 × 75°	1.5 × 12°		2.4 × 25°	
Peak power	2,200 kW	360 kW	200 kW	280 kW		3 kW	2 kW
Gain	38.5 dB	28.5 dB	21 dB				
Pulsewidth	3 µs	125 µs		1/0.25/0.1 µs		0.08/0.5 µs	
PRF	1,250-2,000 pps	280/800/1,000 pps	4,000/900 pps			2,500/840 pps	
Scan rate	7.5/15 rpm	6/12 rpm	15/30 rpm	15 rpm		24 rpm	
Typical range	220 n miles; 30,000 m (100,000 ft)	250 n miles (457 km)	Surveillance - 90 n miles Engagement - 20 n miles	56 n miles (103.6 km)			

* Part of Mk 91 FCS

SONAR

CV 66 and CV 67 are both fitted for SQS 23 sonar, but in neither case is the system installed.

AVIATION



Kitty Hawk (Ian Sturton)

1 *Vulcan/Phalanx 20 mm CIWS* **2** *Mk 29 launcher for NATO Sea Sparrow* **3** *Deck-edge lift; 25.9 × 15.9 m (85 × 52.2 ft); 59,000 kg (130,071 lb) capacity* **4** *Flight deck; 318.8 × 76.8 m (1,046 × 252 ft)* **5** *OE-82 satellite antenna* **6** *SPS-48A long-range air search radar* **7** *SPN-35A approach control radar* **8** *SPS-48C 3D radar*

AVIATION FACILITIES

Specifications:

Flight deck: 318.8 × 76.8 m (1,046 × 252 ft)

Hangar:

CV 63-66: 225.5 × 30.78 × 7.62 m (740 × 101 × 25 ft)

CV 67: 209.7 × 32.31 × 7.62 m (688 × 106 × 25 ft)

Elevators: 4 deck edge; 25.9 × 15.85 m (85 × 52 ft); capacity 58,968 kg (130,000 lb)

Aviation fuel: 5,882 t

Catapults: 4 C-13 steam catapults (3 C-13, 1 C13-1 in CV 66, CV 67)

Arrester wires: 4

Carrier-controlled approach radar suite: 1 SPN-41; J-band; microwave landing aid; 1 ITT-Gilfillan SPN-43A; E-band; aircraft marshalling; 1 SPN-44; F-band; microwave landing aid; 2 Textron SPN-46; microwave, low probability of intercept (LPI) landing aid

Tacan: URN 25

Air wing

A typical air wing for these carriers would be the '50 TACAIR' comprising the following aircraft.

FIXED-WING AIRCRAFT

14 Grumman F-14D Tomcat

Specifications

Role: Fleet fighter aircraft for long-range air defence of task groups; undergoing phased improvements

Wing span:

min sweep: 19.54 m (64.08ft)

max sweep: 11.65 m (38.21 ft)

Length: 19.1 m (62.75 ft)

Height: 4.88 m (16.0 ft)

Operating weight, empty: 18,950 kg (41,780 lb)

Max take-off weight: 33,724 kg (74,349 lb)

Max fuel (internal): 7,348 kg (16,200 lb)

Max weapon load: 6,577 kg (14,500 lb)

Max level speed, high altitude: 1,078 kts (1,997 km/h)

Combat radius (combat air patrol): 1,075 n miles (1,994 km)

Engine: 2 General Electric F110-GE-400 turbofans, each 62.27 kN (14,000 lb) dry; 102.75 kN (23,100 lb) with afterburning

Accommodation: 2

Sensors: APG-71 radar, ALQ-126 jammer, ASN-139, ALR-67 RWR; IRST and JTIDS (Link 16)

Weapons:

air defence: 1 × 20 mm cannon, 6 × AIM-54 Phoenix; AGM-88 HARM and AGM-84 Harpoon/SLAM being added

combat air patrol (CA): 1 × 20 mm cannon, 4 × Phoenix, 2 × AIM-7M, 2 × AIM-9M

reconnaissance: 1 × 20 mm cannon, 2 × AIM-7M, 2 × AIM-9M

36 McDonnell Douglas F/A-18C Hornet

Specifications

Role: Strike interdictor. Some are used for EW support with ALQ-167 jammers

Wing span: 11.43 m (37.5 ft)

Length: 17.07 m (56.0 ft)

Height: 4.66 m (15.28 ft)

Operating weight, empty: 10,455 kg (23,050 lb)

Max take-off weight: 25,401 kg (50,000 lb) (approx)

Max internal fuel: 4,926 kg (10,860 lb)

Max weapon load: 7,031 kg (15,500 lb)

Max level speed, high altitude: 1,033+ kts (1,195 km/h)

Attack radius: 575 n miles (1.065 km) on attack mission

Engine: 2 General Electric F404-GE-402 turbofans, each rated at 78.73 kN (17,700 lb st) with afterburning

Accommodation: 1

Sensors:

ESM: ALR 67, ALQ 165 ASPJ jammer (18D), APG-65 or APG-73 radar, AAS-38 FLIR, ASQ-173 tracker

Weapons:

ASV: 4 × Harpoon or SLAM (18D) or AGM-88 HARM (18D) missiles

Typical weapon loads:

attack mission: up to 7.7 t of bombs.

air defence: 1 × 20 mm Vulcan cannon, 9 × AIM-7/AIM-9 missiles

anti-ship strike: 20 mm gun, 7.7 t bombs, 2 AIM-9 missiles

Five Grumman EA-6B Prowler

Specifications

Role: EW and jamming aircraft to accompany strikes and armed reconnaissance; uprated to ADVCAP standard with new engines and ECM

Wing span: 16.15 m (53.0 ft)

Length: 18.24 m (59.83 ft)

Height: 4.95 m (16.25 ft)

Operating weight, empty: 14,321 kg (31,572 lb)

Max take-off weight: 29,484 kg (65,000 lb)

Max fuel: 6,995 kg (15,422 lb)

Max level speed, low altitude: 566 kts (1,048 km/h)

Range: 955 n miles (1,769 km) (with max external load)

Engine: 2 Pratt & Whitney J52-P-408 each rated at 49.8 kN (11,200 lb st) dry

Accommodation: 4 (pilot, 3 ECM officers (ECMO))

Sensors: APS-130 radar; ALQ-99F, ALQ-149 (ADVCAP) jammers

Weapons: AGM-88 HARM anti-radiation missile capable

Three Grumman E-2C Hawkeye

Specifications

Role: Direction of air defence and strike operations

Wing span: 24.56 m (80.58 ft)

Length: 17.54 m (57.56 ft)

Height: 5.58 m (18.31 ft)

Operating weight, empty: 17,265 kg (38,063 lb)

Max take-off weight: 23,566 kg (51,933 lb)

Max fuel (internal): 5,624 kg (12,400 lb)

Max weapon load: Nil

Max level speed, low altitude: 323 kts (598 km/h)

Operational radius: 175 n miles (320 km) for 3-4 hour patrol

Engines: 2 Allison T56-A-425, each rated at 3,661 kW (4,910 ehp)

Accommodation: 5 (pilot, co-pilot, CIC officer, air control officer, radar operator)

Sensors: ALR-73 PDS; ALQ-108; airborne tactical data system with Links 4A and 11; APS-125/138/145 radar

Weapons: Unarmed

Constellation *(CV 64) with the major part of the air wing on deck. Just one such carrier disposes of more air power than most countries have in their entire air force. Note also the large rectangular antenna atop the short mast for the SPS 48C 3D radar and the Vulcan Phalanx 20 mm CIWS aft* (Jane's/H M Steele)

Eight Lockheed S-3B/ES-3A Viking

Specifications

Role: Anti-submarine aircraft (usually in concert with towed array escorts) and anti-ship. 16 converted to ELINT configuration (ES-3A) to replace obsolete EA-3B in combined EW and targeting roles
Wing span: 20.93 m (68.66 ft)
Length: 16.26 m (53.33 ft)
Height: 6.93 m (22.75 ft)
Operating weight, empty: 12,088 kg (26,650 lb)
Max take-off weight: 23,832 kg (52,540 lb)
Max internal fuel: 5,753 kg (12,863 lb)
Max weapon load: 3,175 kg (7,000 lb)
Max level speed, low altitude: 439 kts (814 km/h)
Attack radius: 945+ n miles (1,751+ km)
Engines: 2 General Electric TF34-GE-2 turbofans rated at 41.26 kN (9,275 lb st) each
Accommodation: 4 (pilot, co-pilot, tactical co-ordinator, sensor operator)
Sensors: APS-137(V)1 radar; APN-200 radar, FLIR, MAD, ASQ-81(V)1, 60 × sonobuoys; ESM: ALR-76; ECM ALE 47; ALE 39 chaff
Weapons:
ASW: 4 × Mk 54 depth charges, 4 × Mk 46/Mk 50 torpedoes
ASV: 2 × Harpoon Block 1C; mines

HELICOPTERS

Three Sikorsky SH-60B/F Ocean Hawk

Specifications

Role: SH-60F Ocean Hawk is a carrierborne inner-zone ASW aircraft which is replacing the SH-3. It is derived from the SH-60B LAMPS III Seahawk, but has a completely different internal fit with all LAMPS III avionics, fairings and equipment removed, including cargo hook and RAST system main and tail probes, although installation provisions are retained. Secondary missions include search and rescue and plane guard
Rotor diameter: 16.36 m (53.75 ft)
Main rotor area: 210.05 m² (2,262.03 sq ft)
Length: 19.76 m (64.83 ft)
Height: 3.63 m (11.92 ft)
Operating weight, empty: 6,191 kg (13,648 lb)
Max take-off weight: 10,659 kg (23,500 lb)
Max fuel: 2,233 litres (590 US gallons)
Max level speed, low altitude: 126 kts (234 km/h)
Operating radius: 150 n miles (278 km) for 1 h loiter
Engine: 2 General Electric T700-GE-401 turboshafts, each rated at 1,260 kW (1,690 shp)
Accommodation: 3 (pilot, co-pilot/airborne tactical officer, sensor operator)
Sensors: Bendix AQS-13F dipping sonar (to be replaced by ALFS), MIL-STD-1553B databus, dual Teledyne Systems ASN-150 tactical navigation computers; Link 11
Weapons: 3 Mk 50 torpedoes

Two Sikorsky HH-60H Rescue Hawk

Specifications

Role: Strike, special warfare support and SAR derivative of the SH-60F
Rotor diameter: 16.36 m (53.75 ft)
Main rotor area: 210.05 m² (2,262.03 sq ft)
Length: 19.76 m (64.83 ft)
Height: 3.63 m (11.92 ft)
Operating weight, empty: 6,114 kg (13,480 lb)
Max internal fuel: 2,233 litres (590 US gallons)
Max level speed, low altitude: 126 kts (234 km/h)
Operational radius: 250 n miles (463 km)
Engines: 2 General Electric T700-GE-401C turboshafts, each rated at 1,471 kW (1,900 shp)
Accommodation: 3 (crew, plus 4 rescued or 8 SEALs)
Sensors: APR-39(XE)2 RWR, AVR-2 laser warning receiver, AN/AAR-47 missile plume detector, AN/ALE-144 IR jammer, ALE-47 chaff/flare dispenser, Cubic AN/ARS-6 personnel locator
Weapons: 2 GECAL 12.7 mm (0.50 in) MGs

PROPULSION

Specifications

System: Steam
Boilers: 8 Foster-Wheeler
Working pressure: 83.4 kg/cm² (1,200 psi)
Working temperature: 510°C (950°F)
Turbines: 4 Westinghouse
Power output: 209 MW (280,000 hp)
Shafts: 4

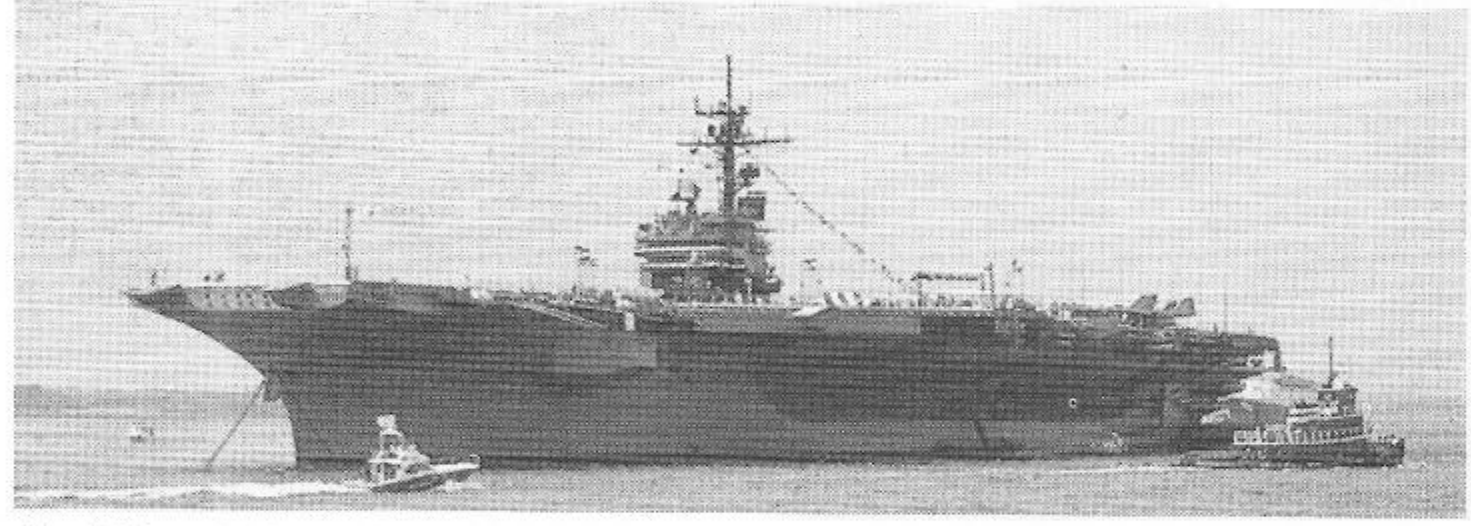
FURTHER INFORMATION

PROGRAMME

It was originally thought that there would be only two of these conventionally powered 'Improved Forrestals', with all subsequent carriers being nuclear-powered. *Kitty Hawk* (CV 63) and *Constellation* (CV 64) were authorised in FY56 and FY57 respectively, their main enhancements being better-designed elevators and a more efficient flight deck layout. However, the costs of nuclear propulsion in *Enterprise* caused major reconsideration of the plan, initial discussion centring on an 'austere nuclear carrier', but the eventual outcome was a decision to build a third 'Kitty Hawk', *America* (CV 66), which was laid down in 1961, and which had a number of enhancements over the first two. There was then another period of discussion before the fourth and final carrier of this class — *John F Kennedy* (CV 67) — was laid down in 1964. *Kennedy* has some major differences from the previous three and is officially considered to be a separate, one ship class. These four carriers are, however, normally considered together, since they have a common flight deck layout and propulsion system.

DESIGN

Compared to the 'Forrestals', these ships have considerable differences to the flight deck and the elevators. On the starboard side the relative positions of the



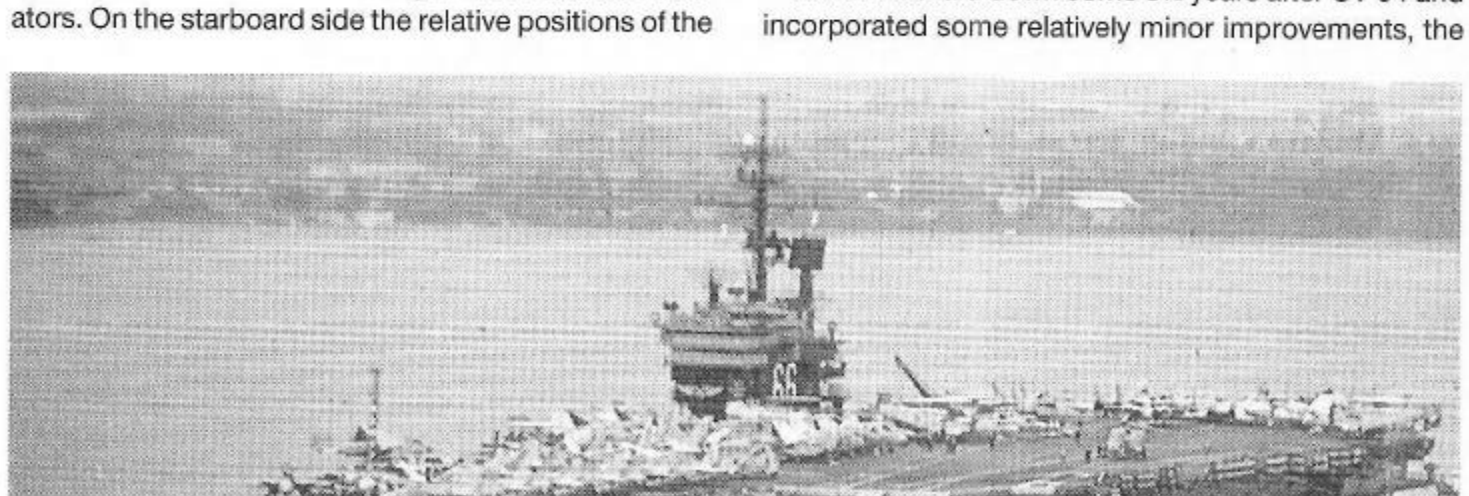
John F Kennedy *(CV 67)* (US DoD)

central elevator and the island superstructure were reversed, which enabled the two forward lifts to serve the catapults. The single port-side elevator, which had been forward in the 'Forrestals' and thus unusable during landing operations, was moved to the after end of the sponson, which meant that two lifts now provided uninterrupted service to the after end of the hangar. In addition, the elevators were given an additional angled segment at their forward end to enable longer aircraft to be carried. These arrangements proved so successful, in particular in making possible simultaneous launching and landing, that they have been followed in all subsequent US carriers.

CV 66 was laid down some 3½ years after CV 64 and incorporated some relatively minor improvements, the most unusual of which was the installation of an SQS-23 sonar in the bow, which necessitated fitting a stern anchor. The SQS-23 has subsequently been removed, but the stern anchor remains.

CV 67 incorporated yet further modifications to the original 'Kitty Hawk' design, one of the most important being that it did not have the Terrier air-defence SAMs fitted to the first three, mounting three octuple Mk 29 launchers for NATO Sea Sparrow, instead. In addition, while provision was made for an SQS-23 sonar, as in CV 66, the equipment was never installed, but, again like CV 66, CV 67 has a stern anchor. In addition, CV 67's hangar is somewhat shorter but wider than those of the earlier three.

Compared to the first pair, CV 66 has a slightly narrower stack, while that on CV 67 is canted outwards.

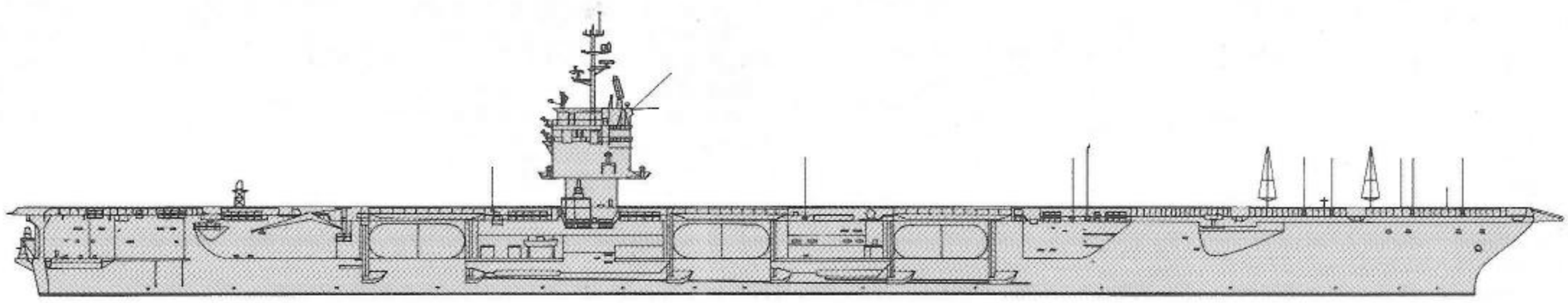


America *(CV 66)* (US DoD)

MODERNISATION

Only two out of the four have undergone Service Life Extension Programs (SLEP): *Kitty Hawk* completed in February 1991 and *Constellation* in December 1992. *Kennedy* underwent a 'complete overhaul' instead of a SLEP; this was funded in FY91, started in September 1993 and completed in September 1995, when it became the reserve and training carrier, which may well include occasional operational deployments. All have a small radar mast abaft the island. *America,* which did not receive a SLEP, is scheduled to pay off in 1996. *Constellation* will be based in Yokosuka from October 1997, replacing *Independence* (CV 62).

ENTERPRISE



Enterprise (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: USA
Type: Aircraft carrier, nuclear-propelled (CVN)

Built: 1
Active: 1

Displacement:
light: 73,502 t
standard: 75,700 t
full load: 93,970 t
Length: 342.3 m (1,123 ft)
Beam: 40.5 m (133 ft)
Draught: 11.9 m (39 ft)

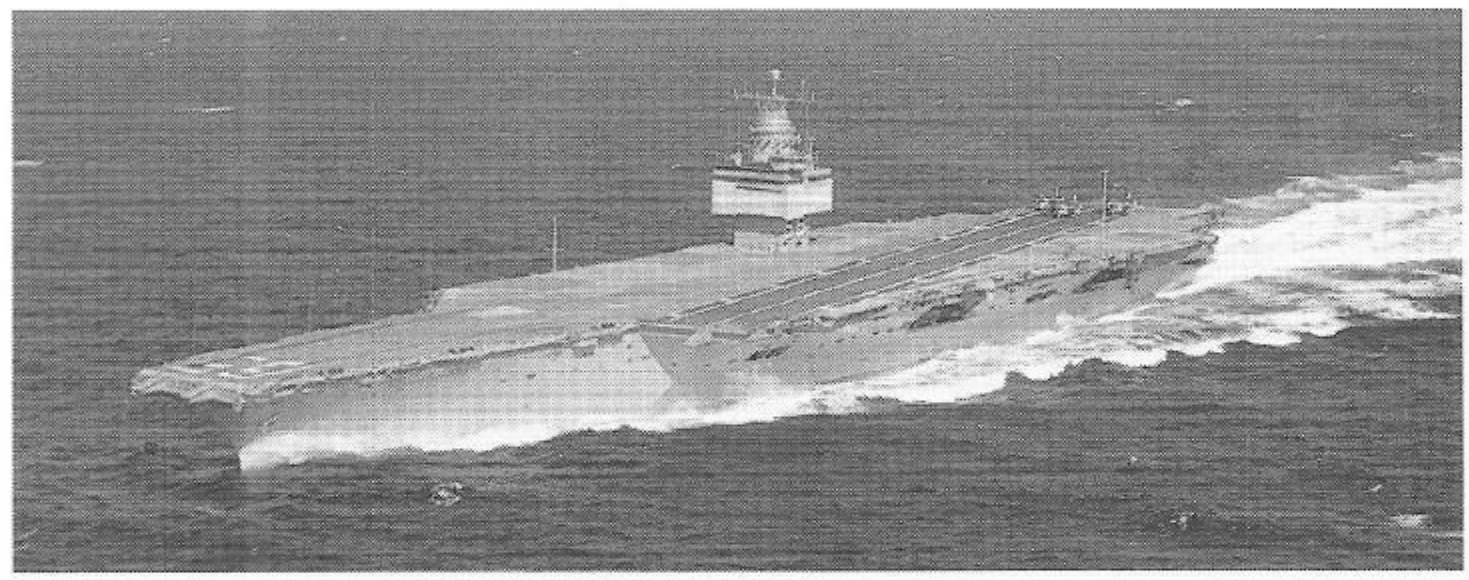
Speed: 33 kts

Complement:
ship's company: 3,215 (171 officers)
air group: 2,480 (358 officers)
Flag staff: 70 (25 officers)

SHIPS

ENTERPRISE (CVN 65)

Builder	Newport News Shipbuilding, Newport News, Virginia, USA
Laid down	4 Feb 1958
Launched	24 Sep 1960
Commissioned	25 Nov 1961



Enterprise, *the world's first nuclear-powered aircraft carrier, undergoing maker's trials in its original form. The island bridge is carrying four huge 'billboard' planar arrays for the SPS-32 and SPS-33 radars, which have been removed*
(Newport News Shipbuilding)

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Raytheon Mk 57 point-defence missile system

Enterprise is fitted with the Mk 57 NSSMS point-defence missile system, which consists of three Mk 29, octuple launchers for the RIM-7 Sea Sparrow missile and three Mk 91 Mod 3 MFCS fire directors. The system is fully automatic from target acquisition to interception. The Sea Sparrow missile, although based upon the air-to-air Sparrow, has been enhanced for launching from ships, and has a 38.6 kg blast fragmentation warhead and a dual-purpose proximity impact fuze.

Specifications
RIM-7M
Length: 3.66 m (12 ft)
Diameter: 20.3 cm (0.67 ft)
Wing span: 1.02 m (3.3 ft)
Weight: 226.8 kg (500 lb)
Speed: Mach 2.5
Range: 8 n miles (14.5 km)
Warhead (WAU-17/B): 38.6 kg (85 lb)
Guidance: Semi-active radar

Manufacturers/Contractors
Raytheon Company, Missile Systems Division, Bedford, Maine, USA (prime missile contractor).
Naval Weapons Center, Crane, USA (warhead).

GUNS

Hughes Mk 15 CIWS Phalanx

Three Hughes Mk 15 Phalanx close in weapons systems (CIWS). These weapons provide the innermost layer of defence against anti-ship missiles and consist of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be three seconds.

Specifications
Gun
Calibre: 20 mm
Barrel length: 53 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)

Mounting
Weight: 5.42 t (Block 0), 6.18 t (Block 1)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s
Power requirement: 440 V, 60 Hz, 3 phase; 18 kW search, 70 kW transient AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor
Hughes Missile Systems, Tucson, Arizona, USA.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES (ECM)

AN/SLQ-32(V)4

Enterprise is fitted with the AN/SLQ-32(V)4 ECM suite, which is generally similar to SLQ-32(V)3, but with some extra facilities to cope with the size of the carriers, one being a fibre optic link between port and starboard units to handle data communications. The system gives radar warning on B-J bands and jamming/deception on H-J bands. The jammer has a maximum radiated power of 1 MW and is capable of forming 64 beams on either side of the ship, with jamming modes including range gate pull off (RGPO) and azimuth gate pull off (AGPO). The system is designed to give four levels of protection: First, warning, identification and directional information on radars associated with the targeting and launch of anti-ship missiles; and, second, jamming to prevent, or at the least, to delay the launch of such missiles. If these measures fail, the system will give all the necessary information on any missiles that are actually launched;

and, finally, it will deflect any such missiles in flight away from their intended target.

Manufacturer/Contractor

Raytheon, Electromagnetic System Division, Goleta, California, USA.

AN/SLQ-25 Nixie noisemaker

One AN/SLQ-25 Nixie (Phase 1), a solid-state, modular design electro-acoustic countermeasures decoy system used to protect the carrier from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 487.5 m (1,599 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408.24 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 94.6 cm (3.1 ft) long, 15.24 cm (0.5 ft) in diameter and weigh 18.14 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body is deployed at a time.

Manufacturer/Contractor

Aerojet ElectroSystems, USA.

DECOYS

Loral Hycor SRBOC

Eight Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications

Launcher

Dimensions: 160 × 43 × 86 cm (5.2 × 1.4 × 2.8 in)
Weight: 173 kg (381.5 lb)
Range: 4 km (2.2 n miles)

Rounds

Mk 182: 1,209 × 130 mm; 22.7 kg
Super Chaffstar: 1,209 × 130 mm; 20.9 kg
Super Gemini: 451 × 130 mm; 5.5 kg
Super Hiram III: 1,220 × 130 mm; 13.6 kg
Super Hiram IV: 467 × 130 mm; 3.8 kg
Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturers/Contractors

Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

Surface Ship Torpedo Decoy System (SSTDS)

Enterprise was fitted with SLQ-36 Nixie in the late 1980s, but this is being progressively replaced by SSTDS.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Advanced Combat Direction System (ACDS)

The Advanced Combat Direction System (ACDS) is installed in all four carriers. This is an enhanced version of the Naval Tactical Data System (NTDS) tactical data handling and target designation system, which interfaces with the Mk 23 TAS. All four carriers currently have a Block 0 system with two AN/UYK-43B processors featuring software modules similar to those in the original NTDS, with a software package containing a database of approximately 1 million lines of code with an additional dedicated package specific to the host ship. The Block 0 system also features improvements in the Link 11 (TADIL A) interface, interfaces to new weapon and sensor systems as well as the replacement of the Hughes Video Signal Simulator (VSS) by the Republic Electronics AN/USQ-93 Radar Environmental Simulator System (RESS). Like NTDS, ACDS Block 0 provides Link 4A (TADIL C), Link 11 (TADIL A) and Link 14 communications. *Constellation*, currently in SLEP, is being fitted with ACDS Block 1 and will carry out trials on the system. All are to be converted by 1997.

Manufacturers/Contractors

Unisys, McLean, Virginia, USA (computers).
Hughes Aircraft Company, Los Angeles, California, USA (displays).
Rockwell International (Collins Avionics/Communications Division), Cedar Rapids, Indiana, USA (communications).

COMMUNICATIONS AND DATALINKS

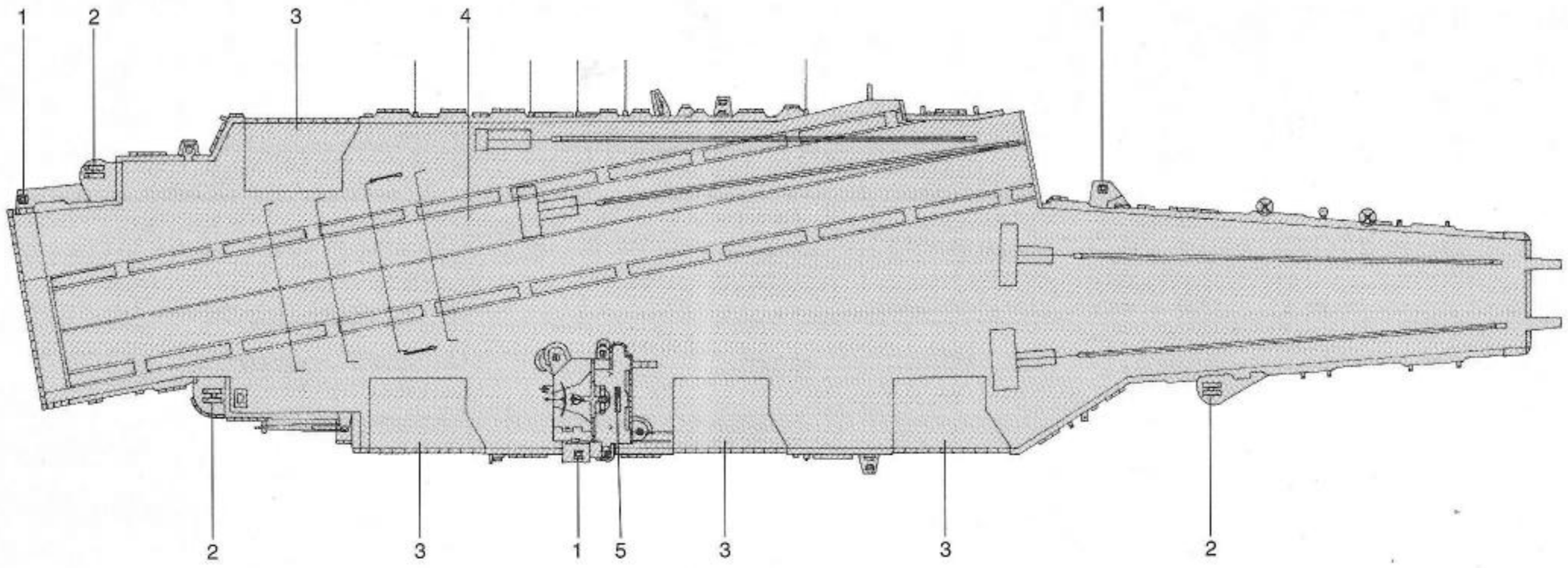
These carriers have the full range of naval communications and datalink systems, including:

Datalinks: Link 4A (TADIL C); Link 11 (TADIL A); Link 14; Link 16 (TADIL J)
C^2 systems: JMCIS; JOTS; POST; CVIC; TESS UMM-1(V)1
Communications satellite systems: SSQ-82, SRR-1; WSC-3 (UHF); WSC-6 (SHF); USC-38 (EHF)
Navigation satellite systems: SRN-9; SRN-19
TIROS-N: SMQ-11 (weather forecasting)
GPS: WRN-6.

RADARS

Type	SPS-48E	SPS-49(V)5	TAS Mk 23	SPS-67(V)1	SPN-64(V)9	904	Mk 95 (six)
Maker	ITT-Gilfillan	Raytheon	Hughes	Westinghouse-Norden	Raytheon	Furuno	
Role	Long-range air search; 3D	Long-range air search; 2D	Target acquisition for Sea Sparrow	Surface search	Navigation	Navigation	Fire control (for Sea Sparrow SAM)*
Band	E/F	C/D	D	G	I	H/I	I/J
Beam	1.5 × 1.6°	3.4 × 30° csc²	3./3 × 75°	1.5 × 12°		2.4 × 25°	
Peak power	2,200 kW	360 kW	200 kW	280 kW		3 kW	2 kW
Gain	38.5 dB	28.5 dB	21 dB				
Pulsewidth	3 µs	125 µs		1/0.25/0.1 µs		0.08/0.5 µs	
PRF	1,250-2,000 pps	280/800/1,000 pps	4,000/900 pps			2,500/840 pps	
Scan rate	7.5/15 rpm	6/12 rpm	15/30 rpm	15 rpm		24 rpm	
Typical range	220 n miles; 3,000 m (100,000 ft)	250 n miles (457 km)	Surveillance - 90 n miles Engagement - 20 n miles	56 n miles (103.6 km)			

* Part of Mk 91 FCS



Enterprise (Ian Sturton)
1 *20 mm Vulcan/Phalanx CIWS* **2** *Raytheon GMLS Mk 29 octuple launcher for NATO Sea Sparrow* **3** *Deck-edge lift; 25.9 × 15.8 m (85 × 52.2 ft); 59,000 kg (130,071 lb) capacity* **4** *Flight deck; 331.6 × 76.8 m (1,088 × 252 ft);* **5** *ITT AN/SPS-48E 3D radar*

AVIATION FACILITIES

Specifications

Flight deck: 331.6 × 76.8 m (1,088 × 252 ft)
Hangar:
dimensions: 262 × 32.6 × 7.62 m (860 × 107 × 25 ft)
area: 20,066 m² (216,000 sq ft)
Lifts: 4 deck-edge lifts, 2 forward and 1 each side abaft the island; 25.9 × 15.8 m (85 × 52 ft), capacity 58,898 kg (130,000 lb)
Catapults: 4—90 m (295 ft) C 13 Mod 1 catapults
Aviation fuel: 8,500 t (sufficient for 12 days' flying at intensive rates
Carrier-controlled approach (CCA): SPN-1, SPN-43A; SPN-44; 2—SPN-46
TACAN: URN-5

Air wing
Enterprise could embark either a '50 TACAIR' wing or a 'Power Projection Air Wing.' The former would comprise the following aircraft.

FIXED-WING AIRCRAFT

14 Grumman F-14D Tomcat

Specifications

Role: Fleet fighter aircraft for long-range air defence of task groups; undergoing phased improvements
Wing span:
min sweep: 19.54 m (64.08 ft)
max sweep: 11.65 m (38.21 ft)
Length: 19.1 m (62.75 ft)
Height: 4.88 m (16.0 ft)
Operating weight, empty: 18,950 kg (41,780 lb)
Max take-off weight: 33,724 kg (74,349 lb)
Max fuel (internal): 7,348 kg (16,200 lb)
Max weapon load: 6,577 kg (14,500 lb)
Max level speed, high altitude: 1,078 kts (1,997 km/h)
Combat radius (combat air patrol): 1,075 n miles (1,994 km)
Engines: 2 General Electric F110-GE-400 turbofans, each 62.27 kN (14,000 lb) dry; 102.75 kN (23,100 lb) with afterburning
Accommodation: 2
Sensors: APG-71 radar, ALQ-126 jammer, ASN-139, ALR-67 RWR; IRST and JTIDS (Link 16)
Weapons:
air defence: 1 × 20 mm cannon, 6 × AIM-54 Phoenix; AGM-88 HARM and AGM-84 Harpoon/SLAM being added
combat air patrol (CA): 1 × 20 mm cannon, 4 × Phoenix, 2 × AIM-7M, 2 × AIM-9M
reconnaissance: 1 × 20 mm cannon, 2 × AIM-7M, 2 × AIM-9M

36 McDonnell Douglas F/A-18C Hornet

Specifications

Role: Strike interdictor. Some are used for EW support with ALQ-167 jammers
Wing span: 11.43 m (37.5 ft)
Length: 17.07 m (56.0 ft)
Height: 4.66 m (15.28 ft)
Operating weight, empty: 10,455 kg (23,050 lb)
Max take-off weight: 25,401 kg (50,000 lb) (approx)
Max internal fuel: 4,926 kg (10,860 lb)
Max weapon load: 7,031 kg (15,500 lb)
Max level speed, high altitude: 1,033+ kts (1,195 km/h)
Attack radius: 575 n miles (1.065 km) on attack mission
Engine: 2 General Electric F404-GE-402 turbofans, each rated at 78.73 kN (17,700 lb st) with afterburning
Accommodation: 1
Sensors:
ESM: ALR 67, ALQ 165 ASPJ jammer (18D), APG-65 or APG-73 radar, AAS-38 FLIR, ASQ-173 tracker
Weapons:
ASV: 4 × Harpoon or SLAM (18D) or AGM-88 HARM (18D) missiles
Typical weapon loads:
attack mission: up to 7.7 t of bombs
air defence: 1 × 20 mm Vulcan cannon, 9 × AIM-7/AIM-9 missiles
anti-ship strike: 20 mm gun, 7.7 t bombs, 2 AIM-9 missiles

Five Grumman EA-6B Prowler

Specifications

Role: EW and jamming aircraft to accompany strikes and armed reconnaissance; uprated to ADVCAP standard with new engines and ECM
Wing span: 16.15 m (53.0 ft)
Length: 18.24 m (59.83 ft)
Height: 4.95 m (16.25 ft)
Operating weight, empty: 14,321 kg (31,572 lb)
Max take-off weight: 29,484 kg (65,000 lb)
Max fuel: 6,995 kg (15,422 lb)
Max level speed, low altitude: 566 kts (1,048 km/h)
Range: 955 n miles (1,769 km) (with max external load)
Engine: 2 Pratt & Whitney J52-P-408 each rated at 49.8 kN (11,200 lb st) dry
Accommodation: 4 (pilot, 3 ECM officers (ECMO))
Sensors: APS-130 radar; ALQ-99F, ALQ-149 (ADVCAP) jammers
Weapons: AGM-88 HARM anti-radiation missile capable

Three Grumman E-2C Hawkeye

Specifications

Role: Direction of air defence and strike operations
Wing span: 24.56 m (80.58 ft)
Length: 17.54 m (57.56 ft)
Height: 5.58 m (18.31 ft)
Operating weight, empty: 17,265 kg (38,063 lb)
Max take-off weight: 23,566 kg (51,933 lb)
Max fuel (internal): 5,624 kg (12,400 lb)
Max weapon load: Nil
Max level speed, low altitude: 323 kts (598 km/h)
Operational radius: 175 n miles (320 km) for 3-4 hour patrol
Engines: 2 Allison T56-A-425, each rated at 3,661 kW (4,910 ehp)
Accommodation: 5 (pilot, co-pilot, CIC officer, air control officer, radar operator)
Sensors: ALR-73 PDS; ALQ-108; airborne tactical data system with Links 4A and 11; APS-125/138/145 radar
Weapons: Unarmed

Eight Lockheed S-3B/ES-3A Viking

Specifications

Role: Anti-submarine aircraft (usually in concert with towed array escorts) and anti-ship. 16 converted to ELINT configuration (ES-3A) to replace obsolete EA-3B in combined EW and targeting roles
Wing span: 20.93 m (68.66 ft)
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Attack radius: 945+ n miles (1,751+ km)
Engines: 2 General Electric TF34-GE-2 turbofans rated at 41.26 kN (9,275 lb st) each
Accommodation: 4 (pilot, co-pilot, tactical co-ordinator, sensor operator)
Sensors: APS-137(V)1 radar; APN-200 radar, FLIR, MAD, ASQ-81(V)1, 60 × sonobuoys; ESM: ALR-76; ECM ALE 47; ALE 39 chaff
Weapons:
ASW: 4 × Mk 54 depth charges, 4 × Mk 46/Mk 50 torpedoes
ASV: 2 × Harpoon Block 1C; mines

HELICOPTERS

Three Sikorsky SH-60B/F Ocean Hawk

Specifications

Role: SH-60F Ocean Hawk is a carrierborne inner-zone ASW aircraft which is replacing the SH-3. It is derived from the SH-60B LAMPS III Seahawk, but has a completely different internal fit with all LAMPS III avionics, fairings and equipment removed, including cargo hook and RAST system main and tail probes, although installation provisions are retained. Secondary missions include search and rescue and plane guard
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Max fuel: 2,233 litres (590 US gallons)
Max level speed, low altitude: 126 kts (234 km/h)
Operating radius: 150 n miles (278 km) for 1 h loiter

Engine: 2 General Electric T700-GE-401 turboshafts, each rated at 1,260 kW (1,690 shp)
Accommodation: 3 (pilot, co-pilot/airborne tactical officer, sensor operator)
Sensors: Bendix AQS-13F dipping sonar (to be replaced by ALFS), MIL-STD-1553B databus, dual Teledyne Systems ASN-150 tactical navigation computers; Link 11
Weapons: 3 Mk 50 torpedoes

Two Sikorsky HH-60H Rescue Hawk

Specifications

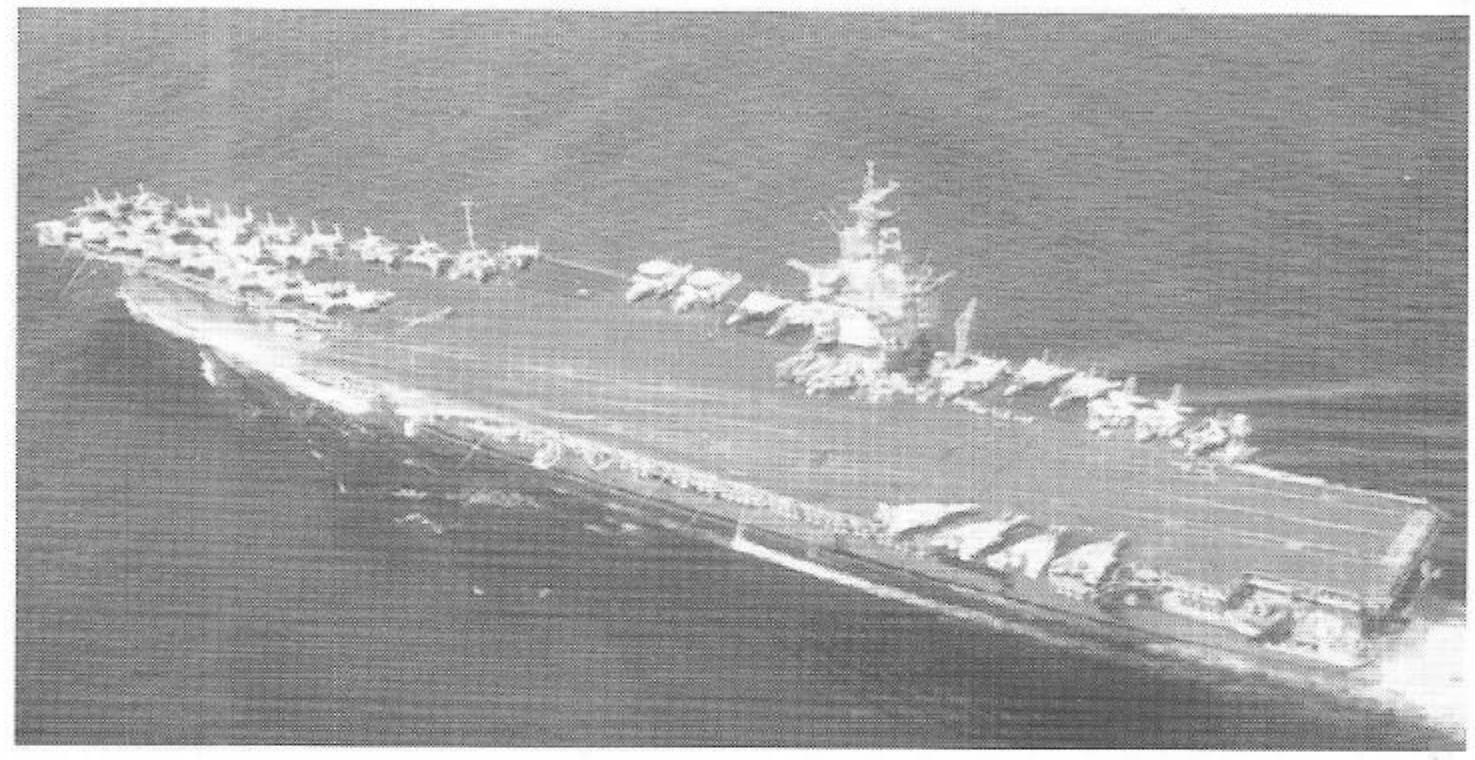
Role: Strike, special warfare support and SAR derivative of the SH-60F
Rotor diameter: 16.36 m (53.75 ft)
Main rotor area: 210.05 m² (2,262.03 sq ft)
Length: 19.76 m (64.83 ft)
Height: 3.63 m (11.92 ft)
Operating weight, empty: 6,114 kg (13,480 lb)
Max internal fuel: 2,233 litres (590 US gallons)
Max level speed, low altitude: 126 kts (234 km/h)
Operational radius: 250 n miles (463 km)
Engines: 2 General Electric T700-GE-401C turboshafts, each rated at 1,471 kW (1,900 shp)
Accommodation: 3 (crew, plus 4 rescued or 8 SEALs)
Sensors: APR-39(XE)2 RWR, AVR-2 laser warning receiver, AN/AAR-47 missile plume detector, AN/ALE-144 IR jammer, ALE-47 chaff/flare dispenser, Cubic AN/ARS-6 personnel locator
Weapons: 2 GECAL 12.7 mm (0.50 in) MGs

PROPULSION

Specifications

System: Nuclear
Nuclear reactors: 8 Westinghouse A2W PWR (pressurised water reactors)
Heat exchangers: 32 Foster-Wheeler
Turbines: 4 Westinghouse
Power output: 209 MW (80,000 hp)
Emergency diesels: 4
Power output: 8 MW (10,720 hp)
Shafts: 4

FURTHER INFORMATION



Enterprise *following reconstruction* (US Navy)

PROGRAMME

Enterprise (CVN 65) was the world's first nuclear-powered aircraft carrier and only the second nuclear-powered surface warship, being beaten into first place by the cruiser USS *Long Beach* (CGN 9). This huge carrier, the largest warship built up to that time, was launched just 31 months after being laid down, and commissioned 14 months after that — a remarkable achievement.

The general design was similar to that planned for the *Kitty Hawk* (CV 63) as regards hull, flight deck and elevators, but a very noticeable difference in the ship's original state was the unique, slab-sided island, which was dominated by the huge flat 'billboards' for the SPS-32 and SPS-33 fixed-array antennas. In an attempt to save money, *Enterprise* was constructed without any missiles or guns.

The *Enterprise* was extremely expensive, costing $451.3 million — approximately twice that of an equivalent conventionally fuelled carrier — and an astronomical sum for the time. Indeed, it was so large that five other warships had to be cancelled to help the navy balance its budget. The justification was based on lower life cycle costs due to infrequent refuelling, coupled with increased utilisation resulting from its ability to proceed to distant areas of tension at sustained high transit speeds. In addition, despite the volume taken up by nuclear reactors and protection, the elimination of fuel bunkers meant that not only could the ship carry 50 per cent more aviation fuel than the 'Kitty Hawk' class, but it could also carry fuel oil to replenish fossil-fuelled ships in company.

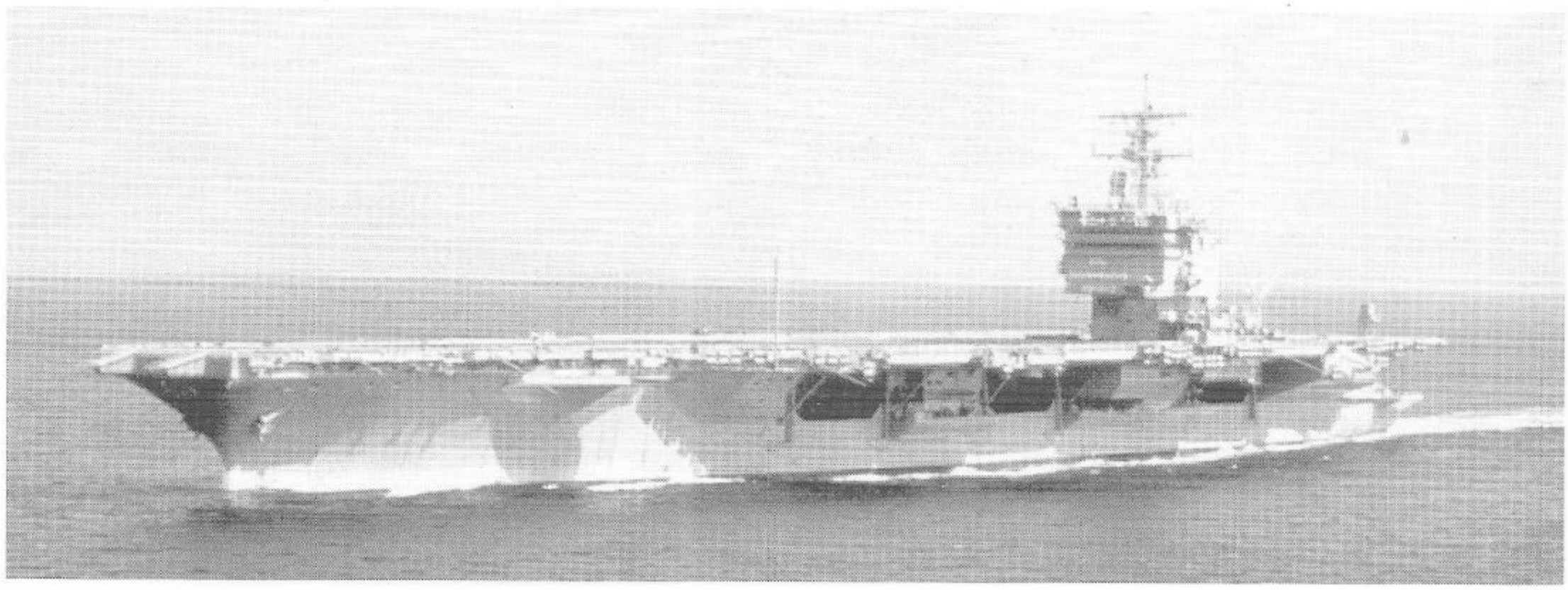
PROPULSION

Work on a nuclear propulsion system for an aircraft carrier began in 1950, culminating in the prototype twin-reactor A1W being constructed at Arco, Idaho. Such was the power required to attain the desired performance, however, that four pairs of A2W reactors, feeding 32 heat exchangers, were required. *Enterprise*'s reactors have been recored four times: November 1964 to July 1965; 1970; and 1991. The carrier steamed more than 207,000 n miles on the first cores and 300,000 n miles on the second set.

MODERNISATION

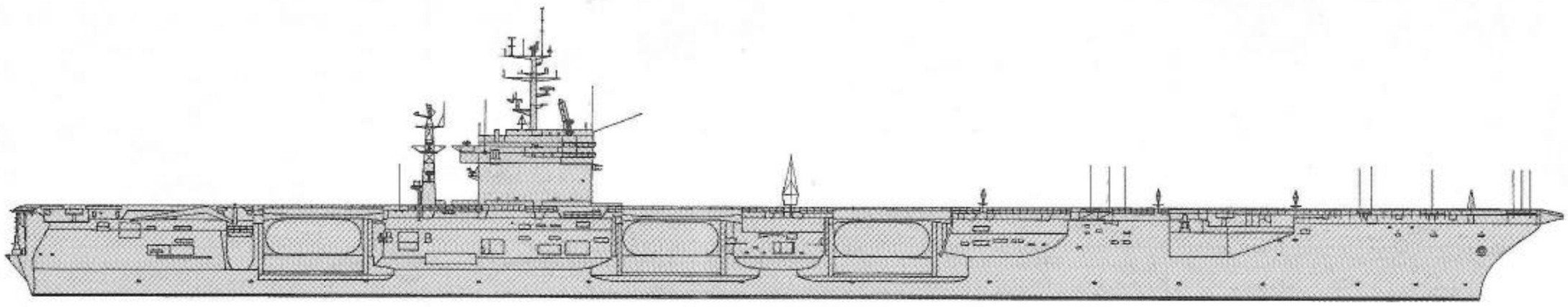
As built, *Enterprise* lacked any armament, but in 1967 two Mk 25 Sea Sparrow BPDMS launchers were installed. The first major refit/overhaul took place at Puget Sound Naval SY, Bremerton, Washington from January 1979 to March 1982, of which the most obvious outward sign was the removal of the SPS-32 and SPS-33 fixed-array antennas. These were replaced by SPS-48 and SPS-49 radars with conventional rotating antennas on a mast similar to that in *Nimitz*. Also during that refit the Mk 25 Sea Sparrow launchers were removed and three Mk 29 NATO Sea Sparrows installed in their place. These were also supplemented with three 20 mm Mk 15 CIWS.

The latest overhaul took place at Newport News, between January 1991 and September 1994. The work included installing SPS-48E and Mk 23 TAS air search radars, SPN-46 precision approach and landing radar, and new C³ and EW systems. Under present plans *Enterprise* is due to remain in service until 2011, serving with the Atlantic Fleet and homeported at Norfolk, Virginia.



Enterprise *undergoing sea trials after reconstruction* (Mike Dillard)

NIMITZ



Carl Vinson (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: USA
Type: Aircraft-carrier, nuclear-powered (CVN)

Class: NIMITZ

Built: 7
Active: 7
Building: 2

Speed: 30+ kts
Complement:
ship's company: 3,184 (203 officers)
air group: 2,800 (366 officers)
Flag staff: 70 (25 officers)

	CVN 68-70	CVN 71	CVN 72-74
Displacement			
Light	72,916 t	73,973 t	73,973 t
Full load	91,487 t	96,386 t	102,000 t
Dimensions			
Length			
pp	317.0 m (1,040 ft)	317.0 m (1,040 ft)	317.0 m (1,040 ft)
oa	332.0 m (1,092 ft)	332.0 m (1,092 ft)	332.0 m (1,092 ft)
Beam	40.8 m (134 ft)	40.8 m (134 ft)	40.8 m (134 ft)
Draught	11.3 m (37 ft)	11.8 m (38.7 ft)	11.9 m (39 ft)

SHIPS

NIMITZ (CVN 68)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 22 Jun 1968
Launched 13 May 1972
Commissioned 3 May 1975

DWIGHT D EISENHOWER (CVN 69)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 15 Aug 1970
Launched 11 Oct 1975
Commissioned 18 Oct 1977

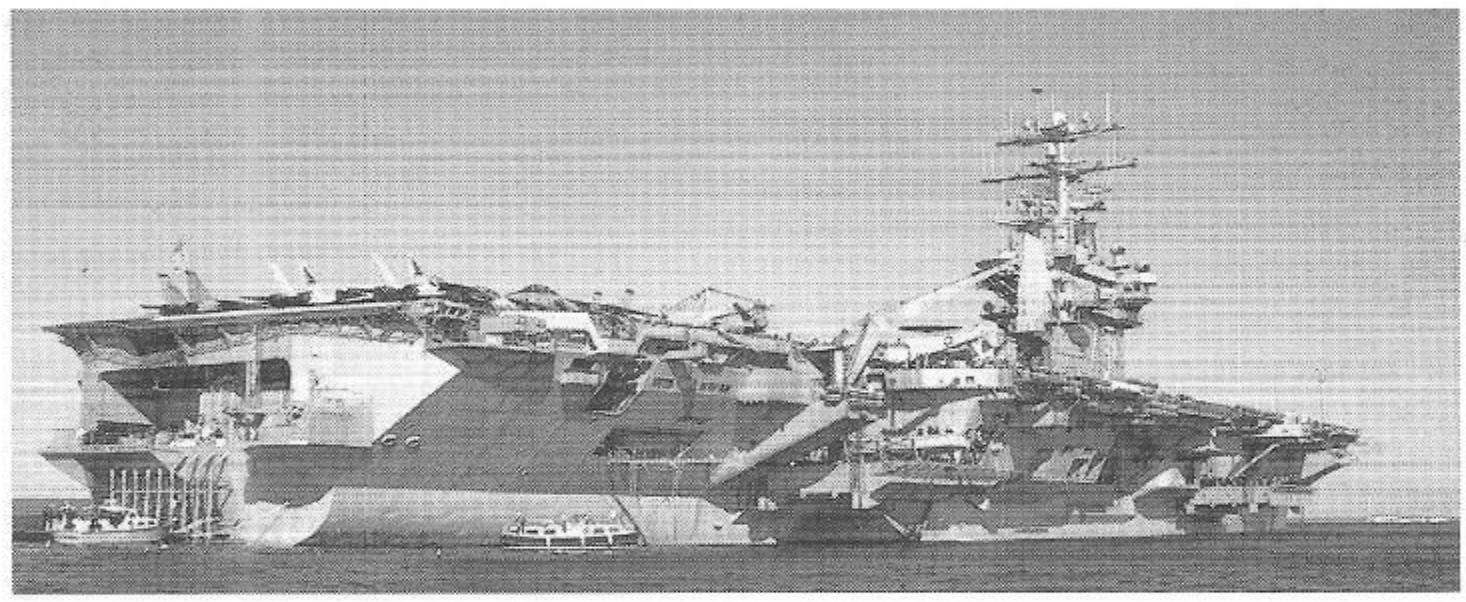
CARL VINSON (CVN 70)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 11 Oct 1975
Launched 15 Mar 1980
Commissioned 13 Mar 1982

THEODORE ROOSEVELT (CVN 71)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 13 Oct 1981
Launched 27 Oct 1984
Commissioned 25 Oct 1986

ABRAHAM LINCOLN (CVN 72)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 3 Nov 1984
Launched 13 Feb 1988
Commissioned 11 Nov 1989

GEORGE WASHINGTON (CVN 73)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 25 Aug 1986
Launched 21 Jul 1990
Commissioned 4 Jul 1992

JOHN C STENNIS (CVN 74)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 13 Mar 1991
Launched 13 Nov 1993
Commissioned 9 Dec 1995



George Washington *(CVN 73)* (Jane's/H M Steele)

Stennis *(CVN 74) on maker's trials. The absence of aircraft makes it possible to see the full extent of the flight deck: 76.8 m (252 ft) in width and 332.9 m (1,092.2 ft) in length. The 'Nimitz' class carriers are, in fact, one of the largest moving objects ever made* (US Navy)

HARRY S TRUMAN (CVN 75)

Builder	Newport News Shipbuilding, Newport News, Virginia, USA
Laid down	29 Nov 1993
Launched	Sep 1996
Commissioned	Jul 1998

RONALD REAGAN (CVN 76)

Builder	Newport News Shipbuilding, Newport News, Virginia, USA
Laid down	Dec 1995
Launched	Jul 1999
Commissioned	Dec 2002

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Raytheon Mk 57 point-defence missile system

All these carriers are fitted with the Mk 57 NSSMS point-defence missile system, which consists of three Mk 29, octuple launchers for the RIM-7 Sea Sparrow missile and three Mk 91 Mod 3 MFCS fire directors. The system is fully automatic from target acquisition to interception. The Seasparrow missile, although based upon the air-to-air Sparrow, has been enhanced for launching from ships, and has a 38.6 kg blast fragmentation warhead and a dual-purpose proximity impact fuze.

Specifications

(RIM-7M)
Length: 3.66 m (12 ft)
Diameter: 20.3 cm (0.67 ft)
Wing span: 1.02 m (3.3 ft).
Weight: 226.8 kg (500 lb)
Speed: Mach 2.5
Range: 8 n miles (14.5 km)
Warhead (WAU-17/B): 38.6 kg
Guidance: Semi-active radar

Manufacturers/Contractors

Raytheon Company, Missile Systems Division, Bedford, Maine, USA (prime missile contractor).
Naval Weapons Center, Crane, USA (warhead).

TORPEDOES

Mk 32 tubes/Mk 46 Mod 7 torpedoes

CVN 70 was the first to be fitted with six 324 mm Mk 32 torpedo tubes in two triple mounts and all the others either have been or will be similarly fitted. These are to launch the Mk 46 Mod 7 torpedo, which is intended to destroy incoming wake-homing torpedoes of the type developed by the Russian Navy.

Specifications

Mk 46 Mod 5
Length: 2.59 m (8.5 ft)
Diameter: 324 mm (12.7 in)
Weight: 230 kg (507 lb)
Warhead: 44 kg (97 lb) (HE)
Propulsion: Liquid propellant
Speed: 45 kts (max)
Range: 5.0 n miles (9.25 km)
Acquisition range: 460 m (503 yd)

Manufacturer/Contractor

Alliant TechSystems Inc, Hopkins, Minnesota, USA.

GUNS

Hughes Mk 15 CIWS Phalanx

There are three Hughes Mk 15 Phalanx close in weapons systems (CIWS) in CVN 68 to CVN 70 and four in the remainder of the class. These weapons provide the innermost layer of defence against anti-ship missiles and consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported as three seconds.

Specifications

Gun
Calibre: 20 mm
Barrel length: 53 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)

Mounting
Weight: 5.42 t (Block 0), 6.18 t (Block 1)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s
Power requirement: 440 V, 60 Hz, 3 phase; 18 kW search, 70 kW transient

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor

Hughes Missile Systems, Tucson, Arizona, USA.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES (ECM)

AN/SLQ-32(V)4

The AN/SLQ-32(V)4 ECM suite is currently installed in *George Washington* (CVN 73) and *John C Stennis* (CVN 74), and will progressively replace the SLQ-29 suite (combined WLR-1, WLR-8, WLR-17 and SLQ-17 radar warning, jammer and deception system) in the others. SLQ-32(V)4 is generally similar to SLQ-32(V)3, but with some extra facilities to cope with the size of the carriers, one being a fibre optic link between port and starboard units to handle data communications. The system gives radar warning on B-J bands and jamming/deception on H-J bands. The jammer has a maximum radiated power of 1 MW and is capable of forming 64 beams on either side of the ship, with jamming modes including range gate pull off (RGPO) and azimuth gate pull off (AGPO). The system is designed to give four levels of protection: first, warning, identification and directional information on radars associated with the targeting and launch of anti-ship missiles; and, second, jamming to prevent, or, at the least, to delay the launch of such missiles. If these measures fail, the system will give all the necessary information on any missiles that are actually launched; and, finally, it will deflect any such missiles in flight away from their intended target.

Manufacturer/Contractor

Raytheon, Electromagnetic System Division, Goleta, California, USA.

AN/SLQ-25 Nixie noisemaker

One AN/SLQ-25 Nixie (Phase 1), a solid-state, modular design electro-acoustic countermeasures decoy system used to protect the carrier from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 487.5 m (1,599 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408.24 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 94.6 cm (3.1 ft) long, 15.24 cm (0.5 ft) in diameter and weigh 18.14 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body is deployed at a time.

Manufacturer/Contractor

Aerojet ElectroSystems, USA.

DECOYS

Loral Hycor SRBOC

Eight Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications

Launcher
Dimensions: 160 × 43 × 86 cm (5.2 × 1.4 × 2.8 in)
Weight: 173 kg (381.5 lb)
Range: 4 km (2.2 n miles)

Rounds
Mk 182: 1,209 × 130 mm; 22.7 kg
Super Chaffstar: 1,209 × 130 mm; 20.9 kg
Super Gemini: 451 × 130 mm; 5.5 kg
Super Hiram III: 1,220 × 130 mm; 13.6 kg
Super Hiram IV: 467 × 130 mm; 3.8 kg
Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturers/Contractors

Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

Surface Ship Torpedo Decoy System (SSTDS)

All were fitted with SLQ-36 Nixie in the late 1980s, but this is being progressively replaced by SSTDS.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Advanced Combat Direction System (ACDS)

The Advanced Combat Direction System (ACDS) is installed in all 'Nimitz' class carriers. This is an enhanced version of the Naval Tactical Data System (NTDS) tactical data handling and target designation system, which interfaces with the Mk 23 TAS. All carriers currently have a Block 0 system with two AN/UYK-43B processors featuring software modules similar to those in the original NTDS, with a software package containing a database of approximately 1 million lines of code with an additional dedicated package specific to the host ship. The Block 0 system also features improvements in the Link 11 (TADIL A) interface, interfaces to new weapon and sensor systems as well as the replacement of the Hughes Video Signal Simulator (VSS) by the Republic Electronics AN/USQ-93 Radar Environmental Simulator System (RESS). Like NTDS, ACDS Block 0 provides Link 4A (TADIL C), Link 11 (TADIL A) and Link 14 communications. *Constellation,* currently in SLEP, is being fitted with ACDS Block 1 and will carry out trials on the system. All are to be converted by 1997.

Manufacturers/Contractors

Unisys, McLean, Virginia, USA (computers).

Hughes Aircraft Company, Los Angeles, California, USA (displays).

Rockwell International (Collins Avionics/Communications Division), Cedar Rapids, Indiana, USA (communications).

COMMUNICATIONS AND DATALINKS

These carriers have the full range of naval communications and datalink systems, including:

Datalinks: Link 4A (TADIL C); Link 11 (TADIL A); Link 14; Link 16 (TADIL J)

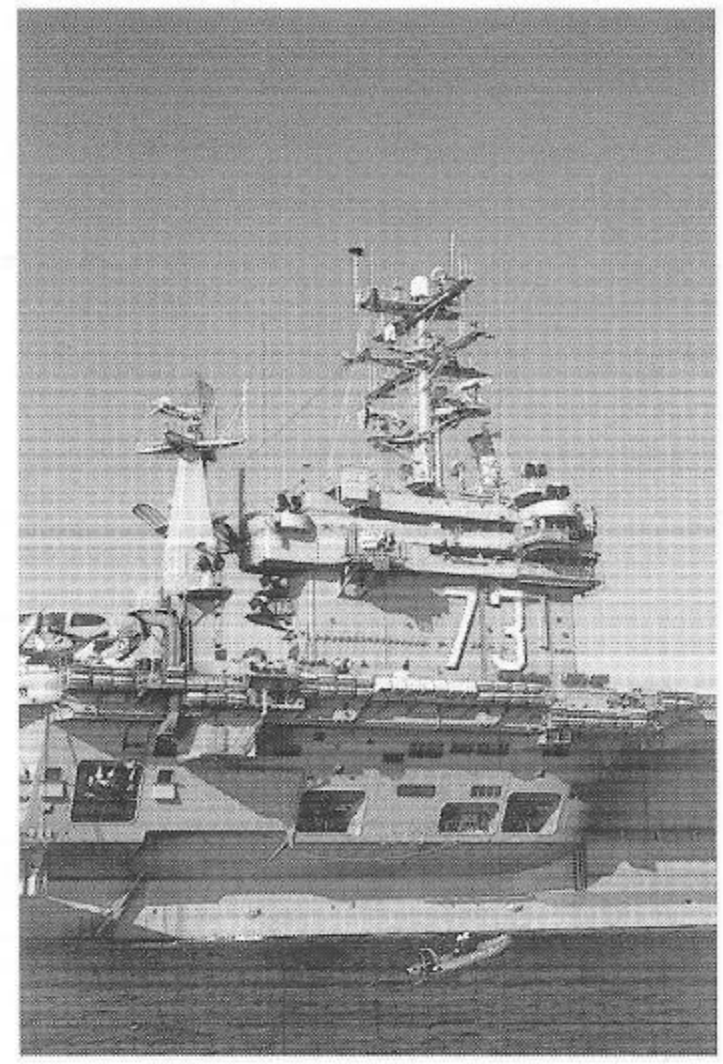
C^2 systems: JMCIS; JOTS; POST; CVIC; TESS UMM-1(V)1

Communications satellite systems: SSQ-82, SRR-1; WSC-3 (UHF); WSC-6 (SHF); USC-38 (EHF)

Navigation satellite receivers: SRN-9; SRN-19

TIROS-N receiver: SMQ-11 (weather forecasting)

GPS receiver: WRN-6.



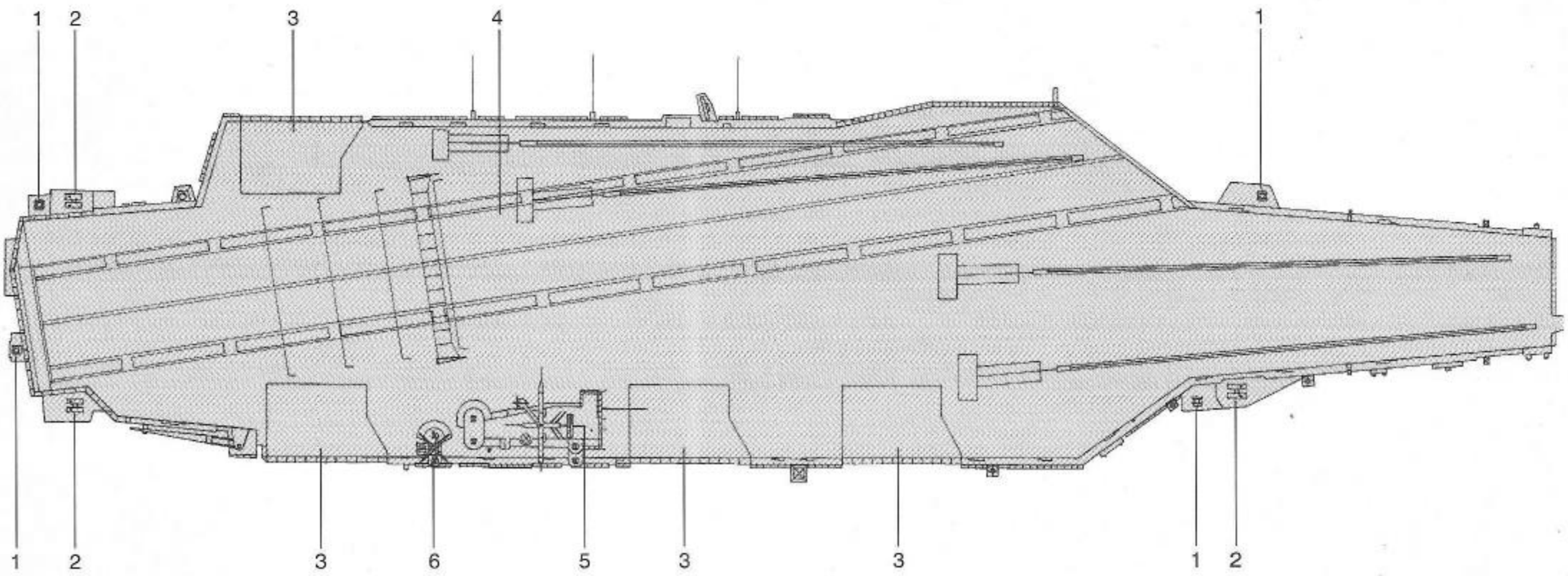
George Washington *(CVN 73). Note the deck-edge lifts, with the curtain open (left) and closed (right). The antenna atop the short mast is the SPS-49(V)E 2D air search radar, while the antenna for the SPS 48E 3D system is atop the bridge*
(Jane's/H M Steele)

RADARS

Type	SPS-48E	SPS-49(V)5	TAS Mk 23	SPS-67(V)1	SPN-64(V)9	904	Mk 95 (six)
Maker	ITT-Gilfillan	Raytheon	Hughes	Westinghouse-Norden	Raytheon	Furuno	
Role	Long-range air search; 3D	Long-range air search; 2D	Target acquisition for Sea Sparrow	Surface search	Navigation	Navigation	Fire control (for Sea Sparrow SAM)*
Band	E/F	C/D	D	G	I	H/I	I/J
Beam	1.5 × 1.6°	3.4 × 30° csc²	3./3 × 75°	1.5 × 12°		2.4 × 25°	
Peak power	2,200 kW	360 kW	200 kW	280 kW		3 kW	2 kW
Gain	38.5 dB	28.5 dB	21 dB				
Pulsewidth	3 µs	125 µs		1/0.25/0.1 µs		0.08/0.5 µs	
PRF	1,250-2,000 pps	280/800/1,000 pps	4,000/900 pps			2,500/840 pps	
Scan rate	7.5/15 rpm	6/12 rpm	15/30 rpm	15 rpm		24 rpm	
Typical range	220 n miles; 3,000 m (100,000 ft)	250 n miles (457 km)	Surveillance - 90 n miles Engagement - 20 n miles	56 n miles			

* Part of Mk 91 FCS

AVIATION



Carl Vinson (Ian Sturton)

1 *20 mm Vulcan Phalanx CIWS* **2** *Mk 29 launcher for NATO Sea Sparrow* **3** *Deck-edge lift; 21.3 × 15.8 m (70 × 52 ft); 47,000 kg (103,635 lb) capacity* **4** *Flight deck; 332.9 × 76.8 m (1,092 × 252 ft)* **5** *SPS 48E 3D radar* **6** *SPS-49(V)E 2D air search radar*

AVIATION FACILITIES

Specifications

Flight deck: 332.9; 237.7 (angled) × 76.8 m (1,092; 779.8 × 252 ft)
Hangar: 208.5 × 32.9 × 8.1 m (684 × 108 × 26.5 ft)
Elevators: 4 (2 at the forward end of the flight deck, 1 to starboard abaft the island and 1 to port at the stern); each 21.3 × 15.8 m (69.9 × 51.8 ft), 47 t capacity.
Catapults: 4 C13 Mod 1
Aircraft launch rate: 1 every 20 s
Arrester wires: Mk 14; 4 on CVN 68-CVN 71; 3 on CVN 72 and later
Crash barrier: Mk 7 Mod 3
Aviation fuel: 9,000 t (sufficient for 16 days at steady flying rates
Aviation ordnance: 1,954 t
Carrier-controlled approach radar suite: 1 SPN-41; J-band; microwave landing aid; 1 ITT-Gilfillan SPN-43B; E-band; aircraft marshalling; 1 SPN-44; F-band; microwave landing aid; 2 Textron SPN-46; microwave, low probability of intercept (LPI) landing aid
TACAN: URN 25

Air wing

These carriers could embark either a '50 TACAIR' wing or a 'Power Projection Air wing'. The latter would comprise the following aircraft.

FIXED-WING AIRCRAFT

20 Grumman F-14D Tomcat

Specifications

Role: Fleet fighter aircraft for long-range air defence of task groups; undergoing phased improvements
Wing span:
min sweep: 19.54 m (64.08 ft)
max sweep: 11.65 m (38.21 ft)
Length: 19.1 m (62.75 ft)
Height: 4.88 m (16.0 ft)
Operating weight, empty: 18,950 kg (41,780 lb)
Max take-off weight: 33,724 kg (74,349 lb)
Max fuel (internal): 7,348 kg (16,200 lb)
Max weapon load: 6,577 kg (14,500 lb)
Max level speed, high altitude: 1,078 kts (1,997 km/h)
Combat radius: 1,075 n miles (1,994 km) (combat air patrol)
Engine: 2 General Electric F110-GE-400 turbofans, each 62.27 kN (14,000 lb) dry; 102.75 kN (23,100 lb) with afterburning
Accommodation: 2
Sensors: APG-71 radar, ALQ-126 jammer, ASN-139, ALR-67 RWR; IRST and JTIDS (Link 16)
Weapons:
air defence: 1 × 20 mm cannon, 6 × AIM-54 Phoenix; AGM-88 HARM and AGM-84 Harpoon/SLAM being added
combat air patrol (CA): 1 × 20 mm cannon, 4 × Phoenix, 2 × AIM-7M, 2 × AIM-9M
reconnaissance: 1 × 20 mm cannon, 2 × AIM-7M, 2 × AIM-9M

24 McDonnell Douglas F/A-18C Hornet

Specifications

Role: Strike interdictor. Some are used for EW support with ALQ-167 jammers
Wing span: 11.43 m (37.5 ft)
Length: 17.07 m (56.0 ft)
Height: 4.66 m (15.28 ft)
Operating weight, empty: 10,455 kg (23,050 lb)
Max take-off weight: 25,401 kg (50,000 lb) (approx)
Max internal fuel: 4,926 kg (10,860 lb)
Max weapon load: 7,031 kg (15,500 lb)
Max level speed, high altitude: 1,033+ kts (1,195 km/h)
Attack radius: 575 n miles (1,065 km) on attack mission
Engine: 2 General Electric F404-GE-402 turbofans, each rated at 78.73 kN (17,700 lb st) with afterburning
Accommodation: 1
Sensors:
ESM: ALR 67, ALQ 165 ASPJ jammer (18D), APG-65 or APG-73 radar, AAS-38 FLIR, ASQ-173 tracker
Weapons:
ASV: 4 × Harpoon or SLAM (18D) or AGM-88 HARM (18D) missiles
Typical weapon loads:
attack mission: up to 7.7 t of bombs
air defence: 1 × 20 mm Vulcan cannon, 9 × AIM-7/AIM-9 missiles
anti-ship strike: 20 mm gun, 7.7 t bombs, 2 AIM-9 missiles

16 Grumman A-6E Intruder

Specifications

Role: All-weather strike and armed reconnaissance aircraft. Updating programme cancelled in mid-1993 after 186 had been modified. All will be phased out by 1997, but with 100 being kept in reserve until 2000
Wing span: 16.15 m (53.0 ft)
Length: 16.69 m (54.66 ft)
Height: 4.93 m (16.17 ft)
Operating weight, empty: 15,525 kg (27,613 lb)
Max take-off weight: 26,580 kg (58,600 lb)
Max internal fuel: 7,230 kg (15,939 lb)
Max weapon load: 8,165 kg (18,000 lb)
Max level speed, low altitude: 560 kts (1,037 km/h)
Attack radius: 878 n miles (1,627 km)
Engines: 2 Pratt & Whitney J52-P-8B each rated at 41.37 kN (9,300 lb st) dry
Accommodation: 2
Sensors: APQ-156 search/attack radar, ALR 67 ESM, RWR, ECM
Weapons:
anti-ship: 2 AGM-84 Harpoon, plus iron bombs
precision attack: up to 8.2 t of underwing stores
self-defence: 4 × AIM-9 Sidewinder or 2 AIM-120 AMRAAM or 2 AIM-7M Sparrow
Suppression of enemy air defences (SEAD): 4 AGM-88 HARM or up to 26 ADM-141 decoy drones
general purpose: Max of 22—227 kg (500 lb) Mk 82 or 10—454 kg (1,000 lb) Mk 83 iron bombs can be carried

Four Grumman EA-6B Prowler

Specifications

Role: EW and jamming aircraft to accompany strikes and armed reconnaissance; uprated to ADVCAP standard with new engines and ECM
Wing span: 16.15 m (53.0 ft)
Length: 18.24 m (59.83 ft)
Height: 4.95 m (16.25 ft)
Operating weight, empty: 14,321 kg (31,572 lb)
Max take-off weight: 29,484 kg (65,000 lb)
Max fuel: 6,995 kg (15,422 lb)
Max level speed, low altitude: 566 kts (1,048 km/h)
Range: 955 n miles (1,769 km) (with max external load)
Engine: 2 Pratt & Whitney J52-P-408 each rated at 49.8 kN (11,200 lb st) dry
Accommodation: 4 (pilot, 3 ECM officers (ECMO))
Sensors: APS-130 radar; ALQ-99F, ALQ-149 (ADVCAP) jammers
Weapons: AGM-88 HARM anti-radiation missile capable

Four Grumman E-2C Hawkeye

Specifications

Role: Direction of air defence and strike operations
Wing span: 24.56 m (80.58 ft)
Length: 17.54 m (57.56 ft)
Height: 5.58 m (18.31 ft)
Operating weight, empty: 17,265 kg (38,063 lb)
Max take-off weight: 23,566 kg (51,933 lb)
Max fuel (internal): 5,624 kg (12,400 lb)
Max weapon load: Nil
Max level speed, low altitude: 323 kts (598 km/h)
Operational radius: 175 n miles (320 km) for 3-4 hour patrol
Engines: 2 Allison T56-A-425, each rated at 3,661 kW (4,910 ehp)
Accommodation: 5 (pilot, co-pilot, CIC officer, air control officer, radar operator)
Sensors: ALR-73 PDS; ALQ-108; airborne tactical data system with Links 4A and 11; APS-125/138/145 radar
Weapons: Unarmed

Six Lockheed S-3B/ES-3A Viking

Specifications

Role: Anti-submarine aircraft (usually in concert with towed array escorts) and anti-ship. 16 converted to ELINT configuration (ES-3A) to replace obsolete EA-3B in combined EW and targeting roles
Wing span: 20.93 m (68.66 ft)
Length: 16.26 m (53.33 ft)
Height: 6.93 m (22.75 ft)
Operating weight, empty: 12,088 kg (26,650 lb)
Max take-off weight: 23,832 kg (52,540 lb)
Max internal fuel: 5,753 kg (12,863 lb)
Max weapon load: 3,175 kg (7,000 lb)
Max level speed, low altitude: 439 kts (814 km/h)
Attack radius: 945+ n miles (1,751+ km)
Engines: 2 General Electric TF34-GE-2 turbofans rated at 41.26 kN (9,275 lb st) each
Accommodation: 4 (pilot, co-pilot, tactical co-ordinator, sensor operator)
Sensors: APS-137(V)1 radar; APN-200 radar, FLIR, MAD, ASQ-81(V)1, 60 × sonobuoys; ESM: ALR-76; ECM ALE 47; ALE 39 chaff
Weapons:
ASW: 4 × Mk 54 depth charges, 4 × Mk 46/Mk 50 torpedoes
ASV: 2 × Harpoon Block 1C; mines

HELICOPTERS

Eight Sikorsky SH-60B/F Ocean Hawk

Specifications

Role: SH-60F Ocean Hawk is a carrierborne inner-zone ASW aircraft which is replacing the SH-3. It is derived from the SH-60B LAMPS III Seahawk, but has a completely different internal fit with all LAMPS III avionics, fairings and equipment removed, including cargo hook and RAST system main and tail probes, although installation provisions are retained. Secondary missions include search and rescue and plane guard
Rotor diameter: 16.36 m (53.75 ft)
Main rotor area: 210.05 m² (2,262.03 sq ft)
Length: 19.76 m (64.83 ft)
Height: 3.63 m (11.92 ft)
Operating weight, empty: 6,191 kg (13,648 lb)
Max take-off weight: 10,659 kg (23,500 lb)
Max fuel: 2,233 litres (590 US gallons)
Max level speed, low altitude: 126 kts (234 km/h)
Operating radius: 150 n miles (278 km) for 1 h loiter
Engine: 2 General Electric T700-GE-401 turboshafts, each rated at 1,260 kW (1,690 shp)
Accommodation: 3 (pilot, co-pilot/airborne tactical officer, sensor operator)
Sensors: Bendix AQS-13F dipping sonar (to be replaced by ALFS), MIL-STD-1553B databus, dual Teledyne Systems ASN-150 tactical navigation computers; Link 11
Weapons: 3 Mk 50 torpedoes

PROPULSION

Specifications
System: Nuclear
Nuclear reactors: 2 General Electric (GE) pressurised water (PWR) A4W/A1G nuclear reactors
Steam turbines: 4
Power output: 194 MW (260,000 hp)
Emergency diesels: 4
Power output: 8 MW (10,720 hp)
Shafts: 4

DAMAGE CONTROL

These carriers are built of high-tensile steel and the hull is extensively divided and subdivided, resulting in over 2,000 individual compartments. There are extensive damage control arrangements, with some 30 DC teams available at all times. Passive DC measures include sides with a system of full and empty compartments (full compartments can contain aviation fuel), and 65 mm (2.5 in) Kevlar plating which has been added during refits to protect the most sensitive areas.

FURTHER INFORMATION

PROGRAMME

The capital cost of the *Enterprise* was so great that it led to a reappraisal of the use of nuclear propulsion for surface warships, with Congress insisting that the second pair of the 'Kitty Hawk' class (*America* and *John F Kennedy*) must be conventionally powered. A second-generation nuclear design was eventually approved, however, which required only two of the new A4W reactors, which resulted in *Nimitz* (CVN 68) being authorised in FY67, followed by *Dwight D Eisenhower* (CVN 69) in FY70, *Carl Vinson* (CVN 70) in FY74, *Theodore Roosevelt* (CVN 71) in FY80, and *Abraham Lincoln* (CVN 72) and *George Washington* (CVN 73) in FY83. Construction contracts for *John C Stennis* (CVN 74) and *Harry S Truman* (CVN 75) were awarded in June 1988, while the FY93 ship construction budget included lead items for *Ronald Reagan* (CVN 76).

All these carriers have been, or are being built at Newport News, the only US shipyard capable of constructing such large, nuclear-propelled surface warships. First-of-class, *Nimitz,* actually took seven years to complete, compared to four for *Enterprise,* although the time for the latest to be completed, *John C Stennis,* was marginally under five years. One cause of delay for *Nimitz* was a series of strikes at the shipyard, coupled with a shortage of skilled workers, and then, when she was launched, vital components for the A4W reactors were delivered late, leading to 22 months between launch and commissioning, compared with 14 for *Enterprise*. These delays had a knock-on effect on the rest of the CVN programme, leading to greatly increased costs, as a result of which President Jimmy Carter sought to replace the fourth ship, *Theodore Roosevelt* (CVN-71) with a smaller, less capable and thus considerably cheaper carrier known as the 'CVV'. This was successfully resisted by the navy and President Reagan subsequently reinstated the full programme.

DESIGN

The flight deck is virtually identical with that of *J F Kennedy* but the internal arrangements have been greatly modified, since the new reactors not only generate 130,000 shp each, but their numbers are reduced from eight to two, which has made a great deal of space available for other uses. These include a 20 per cent increase in the volume available for aviation fuel and for munitions and stores, as well as a major increase in maintenance shops, most of which are located in the large port sponson.

NUCLEAR REACTORS

These ships are powered by two reactors producing 130,000 shp each, compared to 8 reactors of 35,000 shp each in *Enterprise.* In addition to this, however, core life has been greatly extended to 13 years in CVN 68 to 70 and 15 years in CVN 71 onwards. This means that the ships can steam for some 800,000 to 1 million n miles between refuelling.

Some of the funds allocated to the Strategic Sealift programme in FY94 were authorised for the ship construction account and the balance was included in the FY95 budget. Contract awarded 8 December 1994. Work has started on a design for CVN 77.

OPERATIONAL

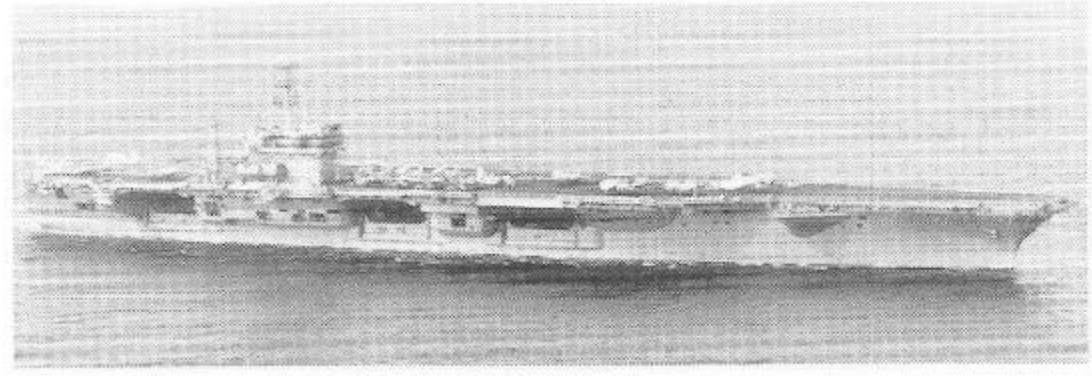
These ships have the multimission role of 'attack/ASW' and all have an Anti-Submarine Classification and Analysis Center (ASCAC) for the latter task. Several practical demonstrations of their flexibility under the 'adaptive force packaging' concept have been given. In December 1992 CVN 71 made a 6-month deployment to the Mediterranean with 600 marines embarked, including six CH-53D and four UH-1N helicopters, which displaced two squadrons of fixed-wing aircraft and two navy helicopters. A second, and on this occasion, operational example, occurred in September 1994 when CVN 69, having disembarked its air wing, ferried 50 army helicopters and support forces to Haiti.

MODERNISATION

All ships have been refitted and progressively modernised throughout their lives. *Nimitz,* for example, was in refit from June 1983 to September 1984 and *Eisenhower* from October 1985 to April 1987, although the order of their second refits has been reversed, with *Eisenhower's* taking place between 1995 and 1997, and *Nimitz'* between 1998 and 2001.

THE FUTURE

CVN 68 -
CVN 69 - 2017
CVN 70 -
CVN 71 - 2036
CVN 72 - 2039
CVN 73 - 2042
CVN 74 - 2045
CVN 75 - 2047
CVN 76 - 2052



Nimitz *(CVN 68)* (US DoD)

Carl Vinson *(CVN 70) showing the layout of the catapults, two over the bows and two over the angled deck, enabling a very high launch rate to be achieved* (US DoD)

SHIPBOARD AIRCRAFT

Helicopters
Fixed-wing

HELICOPTERS

AGUSTA-BELL AB 204 AS

AIRCRAFT

Role: Shipborne anti-submarine helicopter

In naval service: Iran (11); Turkey (3)

SPECIFICATIONS

Dimensions
Rotor diameter: 14.63 m (48.0 ft)
Main rotor disc area: 168.11 m² (1,809.6 sq ft)
Fuselage length (rotors turning): 17.37 m (57.0 ft)
Height: 3.84 m (12.60 ft)

Weights
Operating weight, empty: 2,939 kg (6,480 lb)
Max take-off weight: 4,309 kg (9,500 lb)
Max internal fuel: 916 litres (242 US gallons)

Performance
Max speed: 104 kts (193 km/h)
Service ceiling: 3,200 m (10,500 ft)
Max cruising speed at sea level: 90 kts (167 km/h)
Operational radius: 60 n miles (110 km)

Power plant: 1 General Electric T56-GE-3 rated at 962 kW (1,290 shp)
Fuel: 2 fuel tanks on centre-of-gravity, immediately aft of the cabin, with a total capacity of 916 litres (242 US gallons)
Crew: 3 (Pilot, co-pilot, sensor operator)
Sensors: AQS-13B dunking sonar
Typical weapons loads: 2 Mk 44 or Mk 45 homing torpedoes or 4 AS.12 anti-ship missiles

FURTHER INFORMATION

PROGRAMME

Agusta has manufactured Bell helicopters under licence since the Bell Model 47 Sioux, which went into production in Italy in 1954. Agusta went on to produce a licence-built version of the Bell UH-1 (known around the world as the 'Huey') under the designation AB 204. First flight was in 1961 and first service deliveries took place in 1964, with the general purpose military version being operated for many years by the Italian Air Force and the armed forces of numerous other countries.

Agusta also developed a navalised anti-submarine version — the AB-204AS — which was designed to operate from anti-submarine cruisers and destroyers. This was equipped with long-range fuel tanks and could carry two torpedoes (either Mk 44 or Mk 46) or four AS.12 anti-ship guided missiles. In the ASW role the helicopters worked in pairs, one operating the AQS-13B dunking sonar, while the other carried the torpedoes.

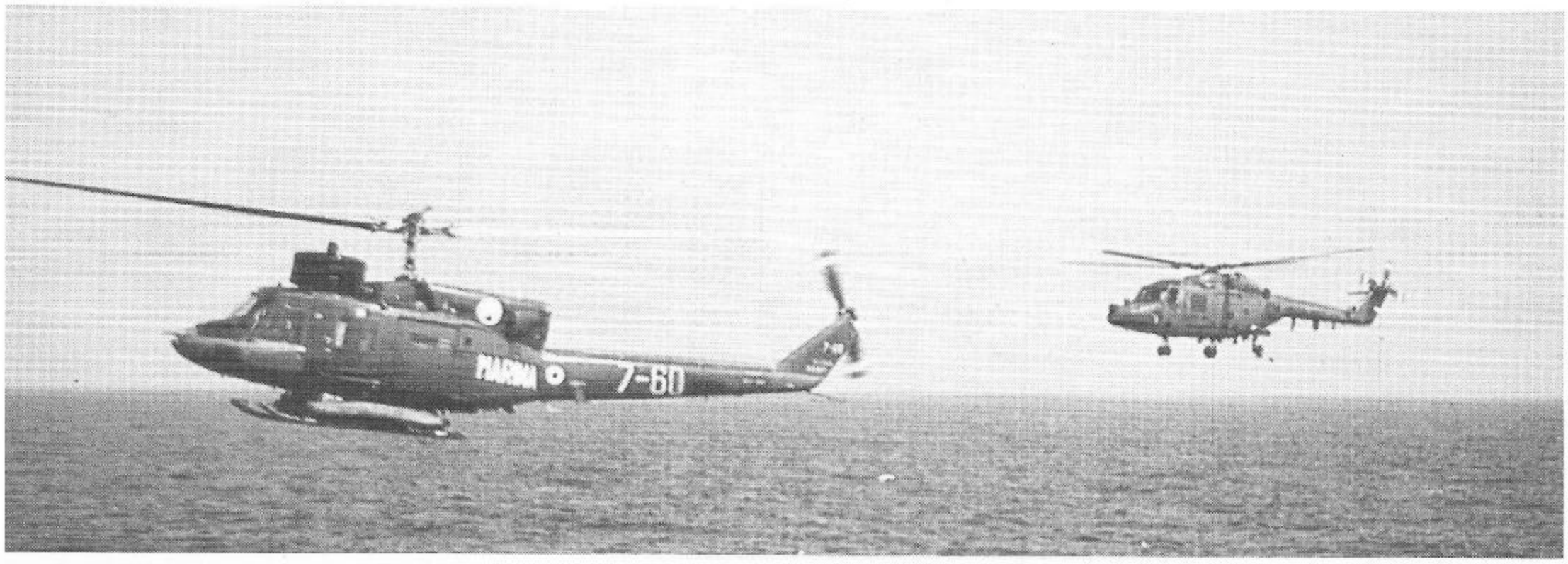
The AB 204AS was operated by the Italian, Spanish and Turkish navies for some years but it is no longer in service with the first two. The Turkish Navy, however, still has three and the Iranian Navy has 11 although not all of the latter may still be serviceable.

AGUSTA-BELL AB 212/BELL UH-1N

AIRCRAFT

Role: Shipborne anti-submarine, anti-ship or electronic warfare helicopters

In naval service:
AB 212: Italy (60); Greece (11); Iran (7 approx); Peru (5); Spain (10); Turkey (9); Venezuela (6)
UH-1N: US Navy (111)



Agusta-Bell AB 212 ASW of Italian Navy with British Navy Lynx in background (NATO — AFSOUTH)

SPECIFICATIONS

Dimensions
Main rotor:
diameter: 14.63 m (48.0 ft)
disc area: 168.10 m² (1,808 sq ft)
Tail rotor:
diameter: 2.59 m (8.50 ft)
disc area: 5.27 m² (56.74 sq ft)
Length overall (both rotors turning): 22.15 m (57.08 ft)
Fuselage length: 12.92 m (42.39 ft)
Height to rotor head: 3.91 m (12.82 ft)

Weights
Operating weight, empty: 3,420 kg (7,540 lb)
Max take-off weight:
ASW: 5,080 kg (11,200 lb)
ASV: 4,973 kg (19,961 lb)

Performance
Never exceed speed (VNE): 130 kts (240 km/h)
Max level speed (clean) (sea level): 106 kts (196 km/h)
Typical cruising speed: 100 kts (185 km/h)
Hovering ceiling (out of ground effect): 396 m (1,300 ft)
Range with max standard fuel: 332 n miles (615 km)
Max endurance: 5 hours

Power plant: 1 Pratt & Whitney Canada PT6T-6 Turbo Twin-Pac rated at 1,398 kW (1,875 shp)
Fuel: Internal tanks with a capacity of 1,021 kg (2,250 lb). Provision for 356 kg (785 lb) additional fuel in 1 internal and 2 external tanks

Accommodation:
ASW: pilot, co-pilot, sonar operator, equipment operator
SAR: pilot, co-pilot, crewman, six passengers
Sensors (according to role):
ESM: Elettronica Gufo 2000 EW intercept equipment
ASW: Bendix AN/AQS-15B/F sonar
ASV: Ferranti Sea Spray search radar
Weapons: 2 Mk 44 or Mk 46 torpedoes, or 4 AS.12 anti-ship guided missiles, or OTOBREDA Sea Killer ASMs

FURTHER INFORMATION

PROGRAMME

The Bell Model 212/UH-1N and its Italian counterpart, the Agusta-Bell 212, were developed from the Bell Model 205/UH-1H, which had, in turn, been developed from the Bell 204. The Model 212 is, in essence, a Model 205 airframe fitted with a Pratt & Whitney Turbo Twin-Pac engine installation, comprising two PT-6 engines with a common gearbox. This gives the Model 212 a considerable advance in capability and performance over earlier types.

Despite their age, some 111 UH-1Ns are still operated by the US Marine Corps, with nine aircraft (plus 18 AH-1Ws) in six active and three reserve composite light attack sqaudrons. The UH-1N is essentially similar to the AB 212 described below, but does not have the specialised anti-submarine equipment. Despite its age the UH-1N is being considered for upgrading. This would involve fitting T700-GE-401 engines; upgraded transmission; a composite, hingeless, bearingless main rotor; and an improved drive train and tail rotor. In addition, the reliability and maintainability of the helicopter would be enhanced.

The AB 212 is in widespread service. The most characteristic feature of this helicopter, which differentiates it from all other UH-1 versions, is the large cylindrical radome on the cabin roof, housing the Ferranti Sea Spray radar.

Proposed UH-1N mid-life upgrade (Bell-Textron)

NAVAL OPERATORS

Greece: Greece has 11 AB 212s, of which two are used for electronic warfare and the remainder for ASW aboard the 'Elli' (Kortenaer) and 'Ipiros' (Knox) class frigates.
Iran: Iran bought 20, of which about seven survive, some of which may be deployed afloat.
Iraq: Iraq ordered 10 AB 212s in the early 1980s but these were never delivered.
Italy: The AB 212 is the standard shipborne helicopter in the Italian Navy. 60 were purchased for use in either the anti-submarine or anti-ship roles.
Peru: Peru operates its five AB 212s in the ASW role from the 'Lupo' class frigates bought from Italy.
Spain: The Spanish Navy has 10 AB 212s, which are employed principally in the anti-ship role, armed with AS.12 missiles, although four also have Elettronica 'Gufo 2000' EW intercept equipment.
Turkey: The Turkish Navy's nine AB 212s operate from the 'Barbaros' and 'Yavuz' class frigates in the anti-ship role, armed with Sea Skua missiles.
Venezuela: Venezuela has six AB 212s, which are operated in the ASW role from the 'Lupo' class frigates bought from Italy.

Agusta-Bell AB 212 ASW with Sea Killer anti-ship missile (Jane's)

Agusta Bell AB 212 fitted with BAe Sea Skua missile (BAe)

AGUSTA/SIKORSKY SH-3 SEA KING

AIRCRAFT

Role: Anti-submarine and general utility helicopter

In naval service: Argentina (5); Brazil (7); Canada (31); Italy (35); Japan (72); Spain (13); Thailand (6 on order); USA (72)

Argentine Navy Sea King (Argentine Navy)

Spanish Navy Sea King AEW (Jane's)

SPECIFICATIONS

Dimensions
Main rotor:
diameter: 18.90 m (62.0 ft)
disc area: 280.5 m² (3,019 sq ft)
Length overall (both rotors turning): 21.91 m (71.88 ft)
Fuselage length: 16.69 m (54.75 ft)
Height to rotor head: 4.74 m (15.55 ft)

Weights
Empty: 5,601 kg (12,350 lb)
Max take-off: 9,525 kg (21,000 lb)
Internal cargo capacity: 2,720 kg (6,000 lb)

Performance
Never exceed speed (VNE): 144 kts (267 km/h)
Typical cruising speed: 120 kts (222 km/h)
Service ceiling: 3,720 m (12,200 ft)
Range with max standard fuel: 630 n miles (1,166 km)

Power plant: 2—1,118 kW (1,500 shp) General Electric T58-GE-100 turboshafts
Fuel: Normal fuel capacity 3,180 litres (840 US gallons)
Accommodation: Crew of 4 in ASW role (pilot, co-pilot, two sonar operators)
Max accommodation:
troop lift: 31 passengers
casualty evacuation: 15 stretchers plus attendant
search and rescue: 25
Sensors:
AS-3H (ASW): AQS-18/AQS-13F sonar; Doppler radar and ASW automatic navigation system; SMA/APS-707 radar with 1/2 transceivers; radio altimeter; marine markers, smoke floats. MAD and EW equipment can also be installed, according to user's requirements
SH-3G/H (US Navy): AN/APS-24 search radar; Bendix AQS-13 dipping sonar; TI ASQ-81(V)2 MAD, 25 sonobuoys
Weapons:
ASW: 2/4 torpedoes (A 244 AS; Mk 44; Mk 46) or 4 depth bombs
ASV: 4 AS.12 medium-range missiles or 2 Marte Mk 2 or 2 Exocet AM 39 or 2 Harpoon

FURTHER INFORMATION

PROGRAMME

Sikorsky won a contract in 1957 to design an ASW helicopter, which resulted in the aircraft designated S-61 by the company and, HSS-2 by the US Navy, although the latter was changed under the 'new' system to SH-3. The Sea King was designed for operation from US Navy carriers, but the type has proved very adaptable, and is operated by many foreign navies from the flight decks of destroyers and even frigates. It exists in many versions — anti-submarine (ASW), anti-surface vessel (ASV), search and rescue (SAR), transport and assault — and has been produced in Canada (United Aircraft of Canada), Italy (Agusta), Japan (Mitsubishi), and the UK (Westland).

The US Navy's force of SH-3s is now rapidly decreasing as they are replaced by SH-60s, but the type will continue in service for many years to come and a new customer, Thailand, has recently placed an order.

Mitsubishi HSS-2B (SH-3A) of the Japanese Maritime Self-Defense Force (Hachiro Nakai)

Italian Navy Agusta-Sikorsky SH-3 Sea King (Ash Amliwala)

NAVAL OPERATORS

Argentina: Argentina has five SH-3Ds and two SH-3Hs, which would serve afloat aboard the carrier *Veinticinco de Mayo* should it return to sea-going duty.
Brazil: The seven Brazilian SH-3D/Hs operate as the close in ASW element of the air wing aboard the carrier *Minas Gerais.*
Canada: Canada possesses 31 licence-built CH-124s, which operate from 'Iroquois' class destroyers, and 'City' and 'Annapolis' class frigates, using the RAST recovery gear. These were to have been replaced by the EH 101 Merlin, but that particular programme has been cancelled.
Italy: The Italian Navy has 35 Agusta-built SH-3Ds, most of which are shore-based. They also provide the ASW element of the air group aboard the carrier *Giuseppe Garibaldi*, but do not deploy aboard cruisers, destroyers or frigates.
Japan: The Japanese Maritime Self-Defense Force (JMSDF) has 72 Mitsubishi-built HSS-2B Sea Kings, which serve aboard all destroyers fitted with flight decks.
Spain: Spain has 10 SH-3D/G with AS-12 missiles, and 3 SH-3D converted to AEW role. All serve either ashore or aboard the carrier *Principe de Asturias.*
Thailand: The Thai Navy is to buy six SH-3s from Spain plus eight new-build SH-3s for use from the carrier *Chakri Naruebet.*
USA: The US Navy has used the SH-3 for carrier battle group inner zone ASW, as well as for liaison and SAR, but the type is now being rapidly replaced by the SH-60F. Nevertheless, some seven SH-3G and 65 SH-3H remain in service in 1996.

EUROCOPTER (AEROSPATIALE) SA 321G SUPER FRELON

AIRCRAFT

Role: Shipborne anti-submarine helicopter

In naval service: China (12); France (18)

SPECIFICATIONS

Dimensions
Main rotor:
diameter: 18.90 m (62.0 ft)
disc area: 280.55 m² (3,019 sq ft)
Tail rotor:
diameter: 4.00 m (13.12 ft)
disc area: 12.57 m² (135 sq ft)
Length overall (rotors turning): 23.03 m (25.58 ft)
Length of fuselage: 19.40 m (63.66 ft)
Width of fuselage: 2.24 m (7.33 ft)
Height overall (blades/tail folded): 4.94 m (16.17 ft)
Wheel track: 4.30 m (14.08 ft)
Cabin door:
height: 1.55 m (5.08 ft)
width: 1.20 m (3.91 ft)

Weights
Empty, equipped: 6,863 kg (15,130 lb)
Max take-off weight: 13,000 kg (28,660 lb)

Performance (at max take-off weight)
Never exceed speed at sea level: 148 kts (275 km/h)
Cruising speed at sea level: 134 kts (248 km/h)
Max climb at sea level: 300 m (985 ft)/min
Service ceiling: 3,100 m (10,170 ft)
Hovering ceiling in ground effect: 1,950 m (6,400 ft)
Normal range at sea level: 440 n miles (815 km)
Range (sea level 3,500 kg (7,716 lb) payload): 549 n miles (1,020 km)
Endurance in ASW role: 4 h

Accommodation: Pilot, co-pilot and flight crew of 3, with capacity for 27 passengers
Power plant: 3 Turbomeca Turmo $IIIC_6$ turboshaft engines, each rated at 1,170 kW (1,570 shp)
Sensors: Full range of ASW detection, tracking and attack equipment, including a self-contained navigation system associated with a Doppler radar, a 360° radar with transponder and display console, and Sylphe panoramic dipping sonar. Omera-Segid Héracles ORB31D or ORB 32 radar for target designation for Exocet missiles
Weapons: Four homing torpedoes can be carried in pairs on each side of the fuselage. 2 Exocet anti-ship missiles
Equipment
Other equipment is carried for towing and minesweeping, and a 275 kg (606 lb) rescue hoist is fitted as standard

Super Frelon lands aboard the frigate La Fayette (DCN)

Super Frelon of the French Navy (Jane's/Paul Tompkins)

FURTHER INFORMATION

PROGRAMME

The design of the Super Frelon was derived from the earlier Frelon, but incorporates technology bought in from other companies: the main and tail rotors were designed with assistance from Sikorsky, for example, while Fiat assisted with the main gearbox and power transmission. 24 Super Frelon SA 321Gs were delivered to the French Navy, of which 20 are still in service, split between two squadrons. There are two versions: the ASW version can be recognised by its prominent chin radome, which is lacking in the SAR/transport version. The boat-shaped hull is sealed, making occasional (but not regular) landings on water feasible.

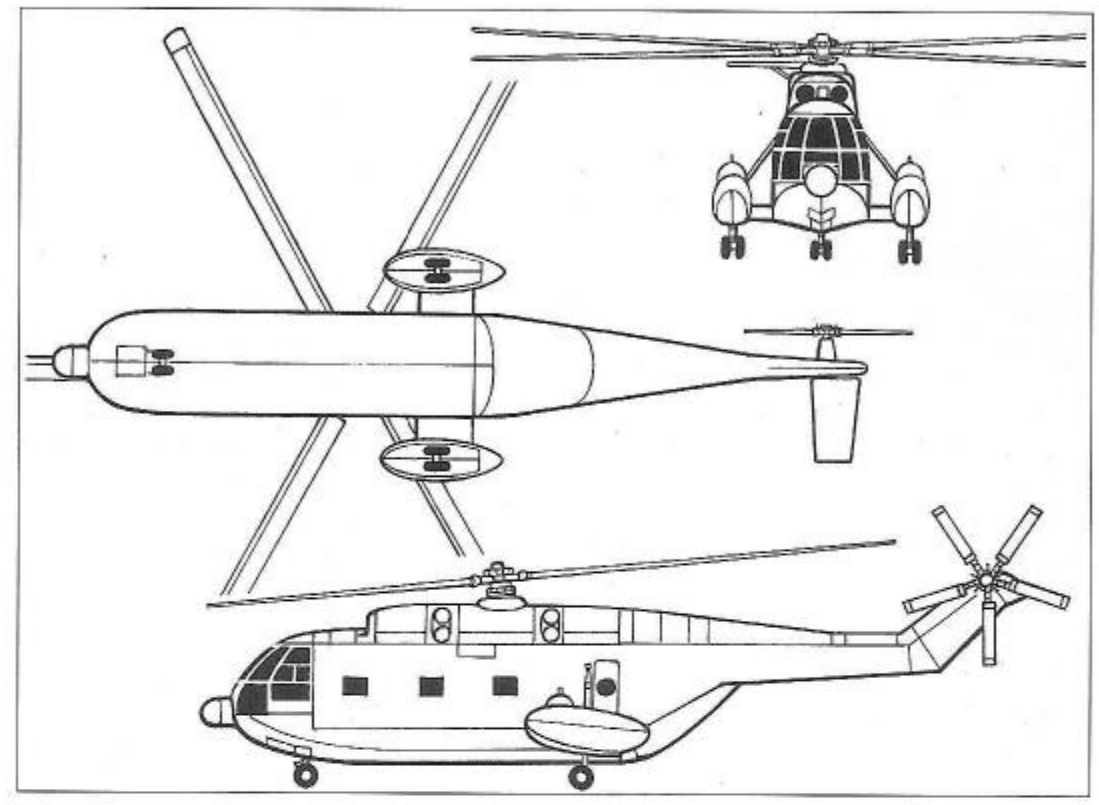
When employed in the ASW role the Super Frelon generally works in groups of up to four aircraft, with one using its dipping sonar, while the others carry out the attack.

NAVAL OPERATORS

France: There are currently two squadrons of Super Frelon: 32 Flotille (32 F) at Lanévoc-Poulmic and 33 Flotille (33 F) at Saint Mandrier.

China: The PLA-Navy received 16 French-built SA-321Ja Super Frelons in the 1970s; all were fitted with the Omera ORB-31D targeting radar and 2 or 3 are believed to have also had the Thomson-Sintra HS-3125 dipping sonar. Nine are believed to be still in service. At the same time, the Changhe Aircraft Factory acquired a licence to build the helicopter, but an exceptionally long development period did not result in a naval version of the CHAIC Z-8 (Zhishenji-8) being handed over to the PLA Navy for service trials until 1989; three are now believed to be in service. This naval version can undertake anti-submarine, anti-ship, search and rescue and minelaying/sweeping missions. Only a relatively small number of PLA-Navy destroyers and frigates have flight decks and these seem somewhat small for such a large helicopter, although Super Frelons operate from the flight deck of the new French 'La Fayette' class frigates.

Super Frelon demonstrates its floating capability (ECP Armées, Paris)



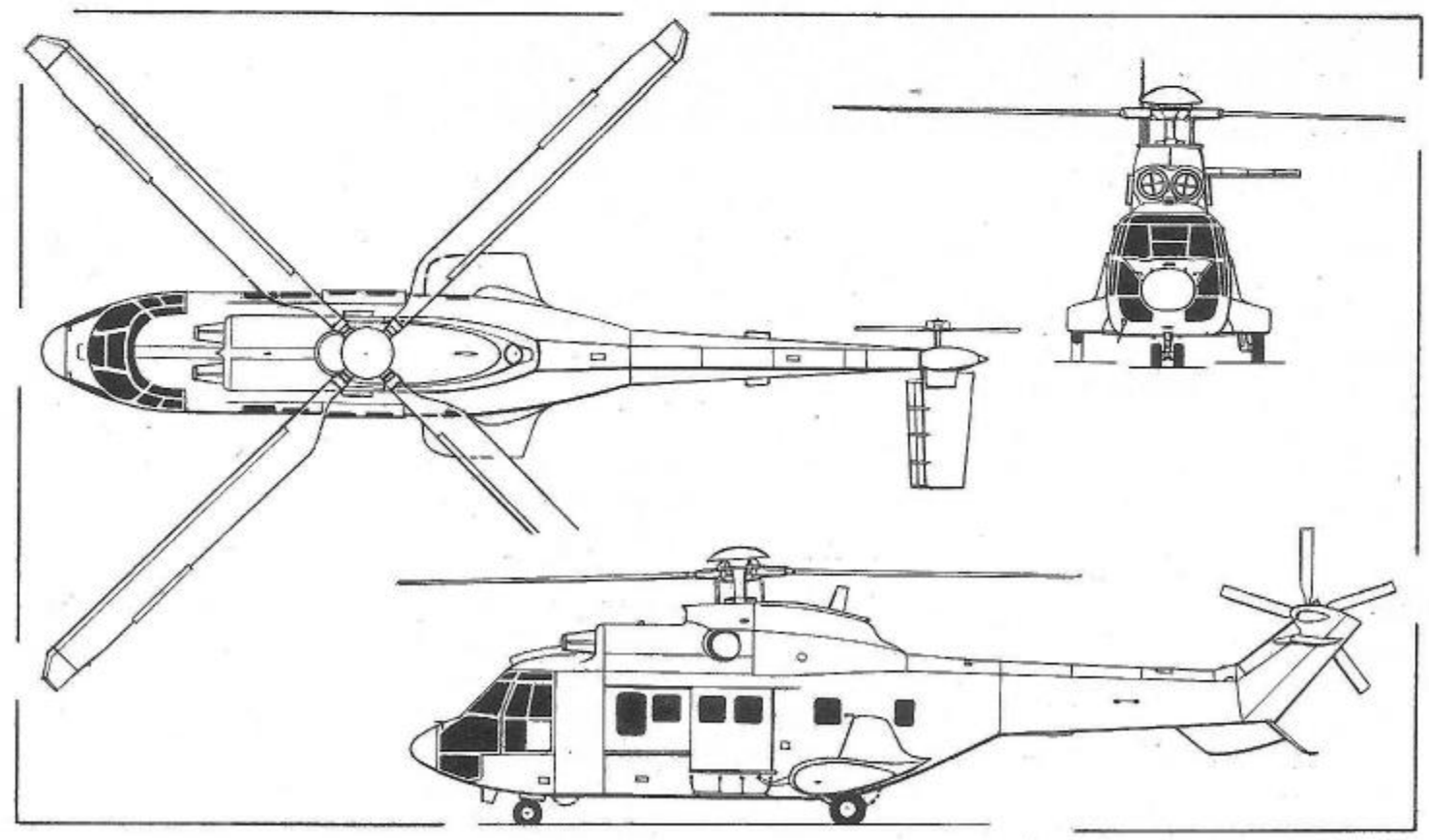
EUROCOPTER (AEROSPATIALE) AS 332/AS 532 COUGAR

AIRCRAFT

Role: Twin-turbine, multirole helicopter

In naval service: Brazil (7); Chile (8); Indonesia (27)

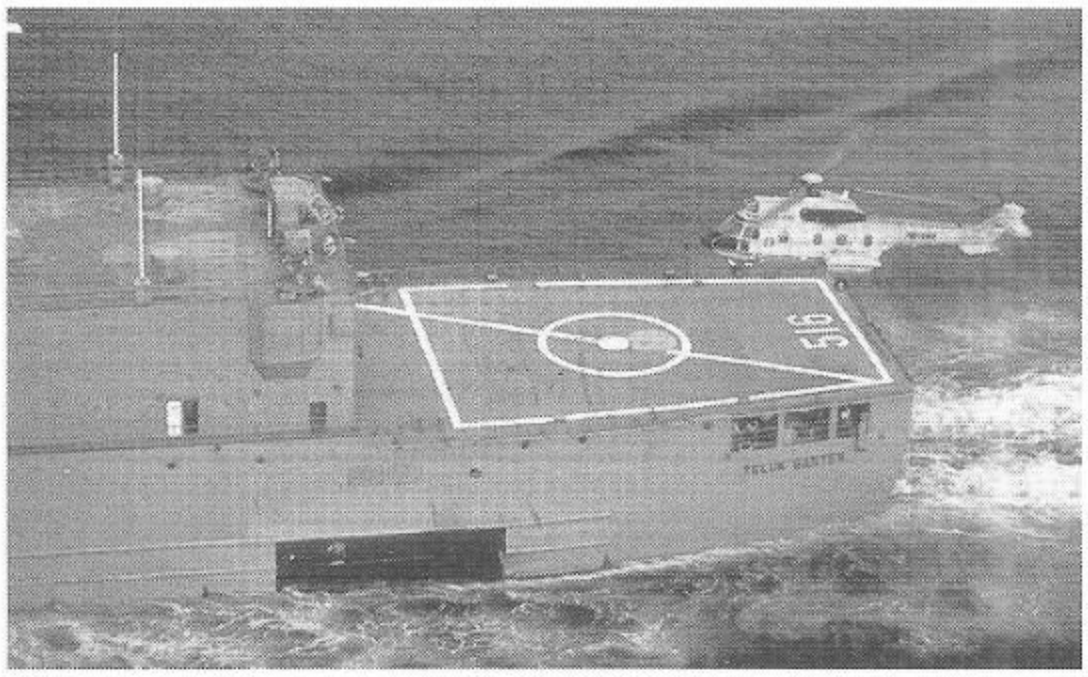
SPECIFICATIONS



Dimensions
Main rotor:
diameter: 15.60 m (51.18 ft)
disc area: 191.1 m² (2,057.4 sq ft)
Tail rotor:
diameter: 3.05 m (10.0 ft)
disc area: 7.31 m² (78.64 sq ft)
Length, overall, rotors turning: 18.70 m (61.35 ft)
Length, fuselage, including tail rotor:
AS 332L1: 16.29 m (53.44 ft)
AS 532SC: 15.53 m (50.95 ft)
Width, blades folded:
AS 332L1: 3.79 m (12.43 ft)
AS 532SC: 4.04 m (13.25 ft)
Height:
overall: 4.92 m (16.14 ft)
blades and tail pylon folded: 4.80 m (15.75 ft)
to top of rotor head: 4.60 m (15.09 ft)
Wheel track: 3.00 m (9.84 ft)
Wheelbase:
AS 332L1: 5.28 m (17.32 ft)
AS 532SC: 4.49 m (14.73 ft)
Passenger cabin doors, each:
height: 1.35 m (4.43 ft)
width: 1.30 m (4.27 ft)

Weights
Weight, empty (standard aircraft):
AS 332L1: 4,460 kg (9,832 lb)
AS 532SC: 4,500 kg (9,920 lb)
Max take-off weight:
AS 332L1, internal load: 8,600 kg (18,960 lb)
AS 532SC, internal load: 9,000 kg (19,841 lb)
all versions, with slung load: 9,350 kg (20,615 lb)

Performance (at max take-off weight)
Never exceed speed (VNE): 150 kts (278 km/h)
Cruising speed at sea level:
AS 332L1: 144 kts (266 km/h)
AS 532SC: 130 kts (240 km/h)
Max rate of climb at sea level:
AS 332L1: 486 m (1,594 ft)/min
AS 532SC: 372 m (1,220 ft)/min
Service ceiling:
AS 332L1: 4,600 m (15,090 ft)
AS 532SC: 4,100 m (13,450 ft)



Indonesian Navy NAS 332B landing aboard the Tacoma-type LST, Teluk Banten (Eurocopter/Aerospatiale)

Close-up of Indonesian NAS 332B (Eurocopter/Aerospatiale)

Hovering ceiling IGE:
AS 332L1: 3,250 m (10,663 ft)
AS 532SC: 2,800 m (9,185 ft)
Hovering ceiling OGE:
AS 332L1: 2,300 m (7,545 ft)
AS 532SC: 1,650 m (5,415 ft)
Range at sea level, standard tanks, no reserves:
AS 332L1/532SC: 470 n miles (870 km)

Power plant: 2 Turbomeca Makila 1A1 turboshafts, each with max contingency rating of 1,400 kW (1,877 shp) and max continuous rating of 1,184 kW (1,588 shp)

Fuel
AS 332L1: Basic fuel system consists of 6 flexible tanks with total capacity of 2,020 litres (533 US gallons) and provision for additional 1,900 litres (502 US gallons) in 4 auxiliary ferry tanks installed in cabin; 2 external auxiliary tanks with total capacity of 650 litres (172 US gallons) optional; for long-range missions (mainly offshore) AS 332L1 can carry a special internal auxiliary tank in cargo sling well, in addition to the 2 external tanks, to raise total usable fuel capacity to 2,994 litres (791 US gallons; 658 Imp gallons)
AS 532SC: Total basic capacity of 2,141 litres (565 US gallons; 471 Imp gallons) and provision for additional 1,900 litres (502 US gallons; 418 Imp gallons) in 4 auxiliary ferry tanks installed in cabin; 2 external auxiliary tanks with total capacity of 650 litres (172 US gallons; 143 Imp gallons) are standard

Accommodation: 1 pilot (VFR) or 2 pilots side by side (IFR) on flight deck, with jump seat for third crew member or paratroop dispatcher; max accommodation for 24 passengers

Avionics
Communications: Optional equipment includes VHF, UHF, tactical HF and HF/SSB radio and intercom

Radar: Search and rescue version has nose-mounted Bendix/King RDR 1400 or chin-mounted Bendix/King 1500 search radar; naval ASW and ASV versions can have nose-mounted Thomson-CSF Varan radar, linked to a tactical table in the cabin, and an Alcatel/Thomson Sintra HS 312 sonar station at rear of cabin

Equipment
Optional fixed or retractable rescue hoist (capacity 275 kg; 606 lb) starboard side; equipment for naval missions can include sonar, MAD and sonobuoys

Armament
Options for naval missions include 2 AM 39 Exocet missiles or 2 lightweight torpedoes, plus 2—20 mm guns or 2—7.62 mm machine guns

AS 332F with two AM.39 Exocet anti-ship missiles (Eurocopter/Aerospatiale)

Brazilian Navy AS 532 Cougar (Brazilian Navy)

FURTHER INFORMATION

PROGRAMME

The Aerospatiale SA 300 Puma first flew in 1965 and has proved a great success, with some 466 helicopters currently in service with 27 navies and air forces, and many more in civil service. Not surprisingly, Aerospatiale expanded on this success by producing a follow-on design, initially known as the AS 332 Super Puma, which first flew in 1978 and entered service in 1981. It is of similar size and layout to the Puma, but is, in fact, virtually a new aircraft. In 1990 the name of the military version was changed to Cougar. Over 400 Cougars are currently in service or on order, of which 39 are specifically for naval forces. There are numerous minor variations in the design which are indicated by suffixes: U — military unarmed utility; A — armed; S — anti-ship/anti-submarine; C: short fuselage military; L — long fuselage, military or civil.

NAVAL OPERATORS

Brazil: The Brazilian Navy operates the Cougar under the national designation UH-14. The navy currently possesses five AS 332F1 and two AS 532SC out of an intended total of 15. Three UH-14s serve as part of the air wing aboard the carrier *Minas Gerais.*
Chile: The Chilean Navy has eight Nurtanio NAS 332SC, which provide the two pairs that operate from the 'Prat' class DLGs (former British 'County' class destroyers).
Indonesia: Indonesian company, Nusantara Aircraft Industries Ltd (IPTN) assembled Pumas from kits supplied by Aerospatiale, followed by Super Pumas, which were designated NAS 332B. The Indonesian Navy currently operates 27 of these NAS 332Bs (which are essentially similar to the AS 332SC), some of which operate from the last two of the 'Tacoma' class LSTs.

NAS 332SC of the Chilean Navy landing on and about to engage the Indal RAST (Indal)

NAVAL VARIANTS

AS 332L1 Super Puma: Standard Mk I civil version with long fuselage and airline interior for 20 passengers; UK CAA IFR certification 21 April 1992.
AS 532SC Cougar: Naval short Mk I version with ASW/ASV equipment; folding tail rotor pylon and main rotor blades; deck harpoon device.

Cougar naval variant, equipped with dipping sonar and torpedo (Eurocopter/Aerospatiale)

EUROCOPTER (AEROSPATIALE) AS 350/355 ECUREUIL and AS 550/555 FENNEC

AIRCRAFT

Type: Five/six-seat light, general purpose helicopter

In naval service: Australia (6); Brazil (19); Mexico (4); Paraguay (2)

SPECIFICATIONS

Eurocopter (Aerospatiale) AS 555 AF Fennec of the Mexican Navy (Mexican Navy)

UH-12 (AS 350B) of the Brazilian Navy (Brazilian Navy)

Dimensions
Main rotor:
diameter: 10.69 m (35.07 ft)
disc area: 89.75 m² (966.1 sq ft)
Tail rotor:
diameter: 1.86 m (6.10 ft)
disc area: 2.72 m² (29.25 sq ft)
Length:
overall, rotors turning: 12.94 m (42.45 ft)
fuselage: 10.93 m (35.86 ft)
Fuselage width: 1.80 m (5.91 ft)
Height overall:
AS 350/355: 3.14 m (10.30 ft)
AS 550/555: 3.34 m (10.96 ft)
Skid track:
AS 350/355: 2.17 m (7.12 ft)
AS 550/555: 2.28 m (7.48 ft)

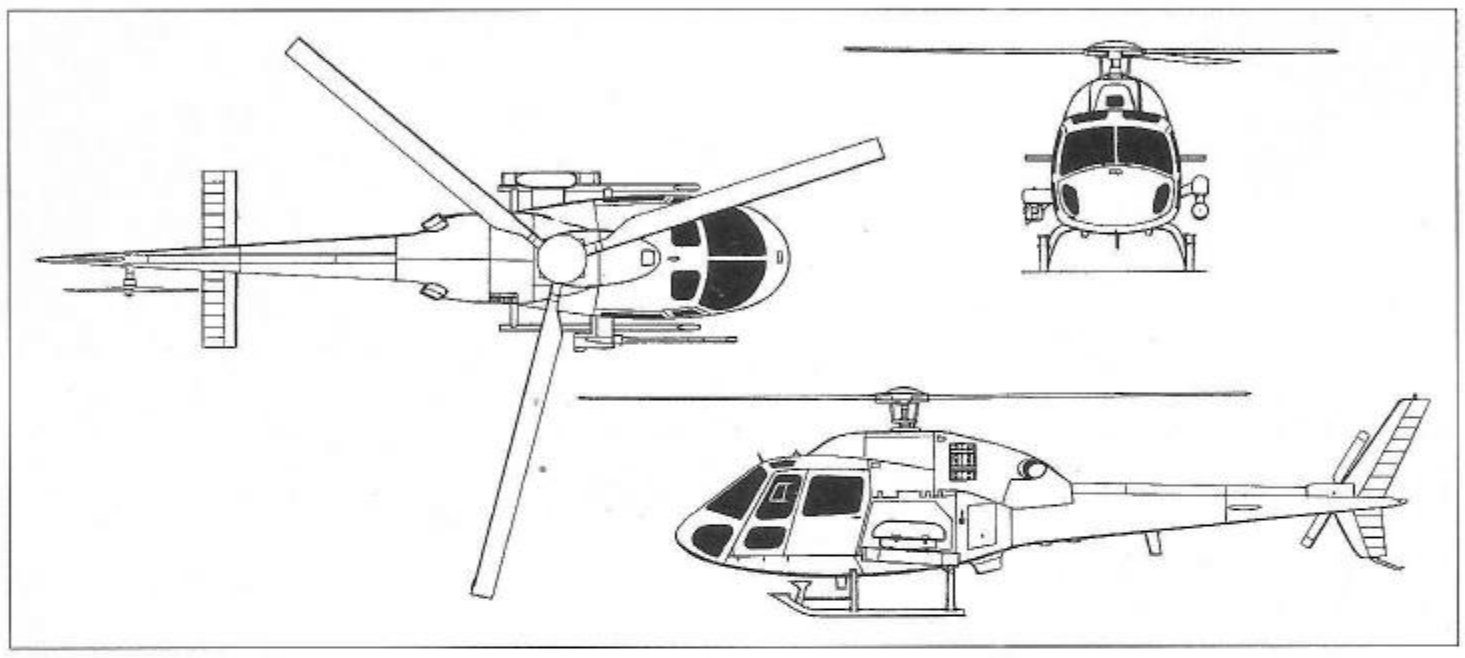
Weights
Weight empty:
AS 350B2: 1,153 kg (2,542 lb)
AS 550: 1,220 kg (2,689 lb)
AS 555: 1,382 kg (3,046 lb)
Max take-off weight:
AS 350B2/550: 2,250 kg (4,960 lb)
AS 555: 2,600 kg (5,732 lb)
Max weight with slung load:
AS 350BA: 2,250 kg (4,960 lb)

Performance (AS 350B2/550 at 2,200 kg; 4,850 lb)
Never exceed speed (VNE) at sea level:
AS 350B/550: 155 kts (287 km/h)
AS 555: 150 kts (278 km/h)
Max cruising speed at sea level:
AS 350B2/550: 133 kts (246 km/h)
AS 555: 121 kts (225 km/h)
Max rate of climb at sea level:
AS 350BA: 456 m (1,500 ft)/min
AS 350B2/550: 534 m (1,750 ft)/min

Service ceiling (AS 350BA/B2/550): 4,800 m (15,750 ft)
Hovering ceiling OGE (AS 350B2/550): 2,550 m (8,350 ft)

Range with max fuel at recommended cruising speed, no reserves:
AS 350B2/550: 360 n miles (666 km)
AS 555: 389 n miles (722 km)

Anti-submarine and over-the-horizon targeting version of the AS 355 M2 Ecureuil 2 (Eurocopter/Aerospatiale)



Eurocopter AS 555 AN Fennec twin-turbine armed helicopter (Jane's/Dennis Punnett)

Power plant
AS 350B2: 1–546 kW (732 shp) Turbomeca Arriel 1D1
AS 355: 2 Turbomeca TM 319 1A Arrius turboshafts, each rated at 357 kW (479 shp) for take-off and 302 kW (406 shp) max continuous; 379 kW (509 shp) 30 min OEI emergency

Fuel
AS 350/550: Plastic fuel tank (self-sealing on AS 550) with capacity of 540 litres (142.6 US gallons)
AS 355/555: 2 integral fuel tanks in body structure, with total usable capacity of 730 litres (193 US gallons)

Accommodation: Pilot, co-pilot in individual bucket seats at front of cabin; max of 4 passengers on rear bench seat. Optional ambulance layout. Sliding doors standard on military versions

Avionics
Communications: VHF/AM radios, HF/SSB transponder and ICS.
Flight: VOR/ILS, ADF, marker beacon receiver and DME. SFIM PA 85T31 (IFR), Honeywell HelCis or Collins APS-841H autopilot.

Equipment
Includes 907 kg (2,000 lb) capacity cargo sling (1,160 kg; 2,557 lb for AS 350B2/550) and 135 kg (297 lb) capacity electric hoist.

Armament
AS 550: Provision for wide range of weapons, including 20 mm GIAT M621 gun, FN Herstal TMP twin 7.62 mm machine gun pods, TDA 68.12 launchers for 12–68 mm rockets, Forges de Zeebrugge launchers for 7–2.75 in rockets, and ESCO HeliTOW anti-tank missile system.
AS 555: Optional alternative weapons include TDA or Forges de Zeebrugge rocket packs, Matra or FN Herstal machine gun pods or a GIAT M621 20 mm gun. Naval version carries 1 homing torpedo in ASW role, or SAR winch.

FURTHER INFORMATION

PROGRAMME

The AS350/550 series has proved to be very successful. The first prototype, powered by a Lycoming engine, flew for the first time on 27 June 1974, followed by the second prototype powered by the definitive Turbomeca Arriel in February 1975. The AS 350 Ecureuil is the basic, single-engined, civil helicopter, which is available in a number of versions, powered either by the Turbomeca Arriel turboshaft or the Lycoming LTS-101, the latter being intended specifically for the US market. Some military and naval orders have been placed for the AS 350, although the AS 550 Fennec version has been developed specifically for military/naval use. This possesses features specifically tailored for the military market, such as taller landing gear, sliding doors, night-vision goggle-compatible cockpit, reinforced airframe and provision for armoured seats.

The AS 355 Ecureuil is a twin-engined version of the design, with related changes to the transmission, fuel system and fuselage structure. Again, there is a military/naval version, designated AS 555 Fennec, but Eurocopter is also offering a specialised naval version, AS 555SR, which has a Bendix 1500 radar and Crouzet MAD, and is armed with torpedoes, cannon or rockets.

The Brazilian company Helibras has undertaken assembly of these helicopters for the South American market, all of which are named Esquilo, the Portuguese name for the squirrel. One series is similar to the AS 350B, with two models HB 350B/B1 (unarmed) and HB 350L1 (armed); the navy operates 39 under the designation UH-12A. Helibras also assembles the AS 355 as the HB 355F2, of which the navy operates 11 under the designation UH-12B.

A total of 1,850 single-engined AS 350s of all types had been ordered from 62 countries by 1 January 1995, of which 1,816 had been delivered. 581 of the twin-engined AS 355/555 had been ordered by 1 January 1995, of which 551 had been delivered.

AS 550 A2 Fennec with rocket pod and 20 mm cannon (Eurocopter/Aerospatiale)

NAVAL OPERATORS

Australia: Six AS 350B Squirrel. They are used for liaison and anti-ship missions, and in the latter role will carry two machine guns. They may be deployed aboard 'Adelaide' (Oliver Hazard Perry) class frigates.
Brazil: 10 UH-12 (HB 350A/B) and nine UH-13 (HB 355) Esquilo helicopters, which are used for fleet liaison and light transport for marines. They can be armed with two Avibras LM-70/7 pods each containing seven SBAT 70 mm rockets, or two FN Herstal twin 7.62 mm MAG machine gun pods and a door-mounted MAG pedestal. They are deployed aboard *Minas Gerais* (two) and are also seen on frigates/destroyers.
Mexico: Four AS 555AF Fennec, which are used for EEZ protection and search and rescue. They are equipped with Bendix 1500 search radar and can be armed with two torpedoes, rocket pods or machine guns. They are deployed aboard frigates and patrol vessels.
Paraguay: Two Helibras HB 350B Esquilos are used as support helicopters embarked in riverine patrol craft.

NAVAL VARIANTS

AS 350B Ecureuil: Used by Australian (6), Brazilian (19), French (22) and Paraguayan (2) navies.
AS 555AF Fennec: Used by Mexican Navy (4). Fitted with Bendix 1500 search radar and can carry 2 torpedoes, rocket pods or machine guns.

EUROCOPTER (AEROSPATIALE) AS 565 PANTHER

AIRCRAFT

Role: Twin-engined, multirole, naval helicopter

In naval service: Abu Dhabi (7); China (50); France (18); Ireland (5); Israel (20 on order); Saudi Arabia (4 on order); Thailand (9)

SPECIFICATIONS

AS 365N2 of Royal Saudi Navy; note Fenestron (shrouded tail rotor)

Chinese-manufactured HAMC Z-9A Haitun (CMIE)

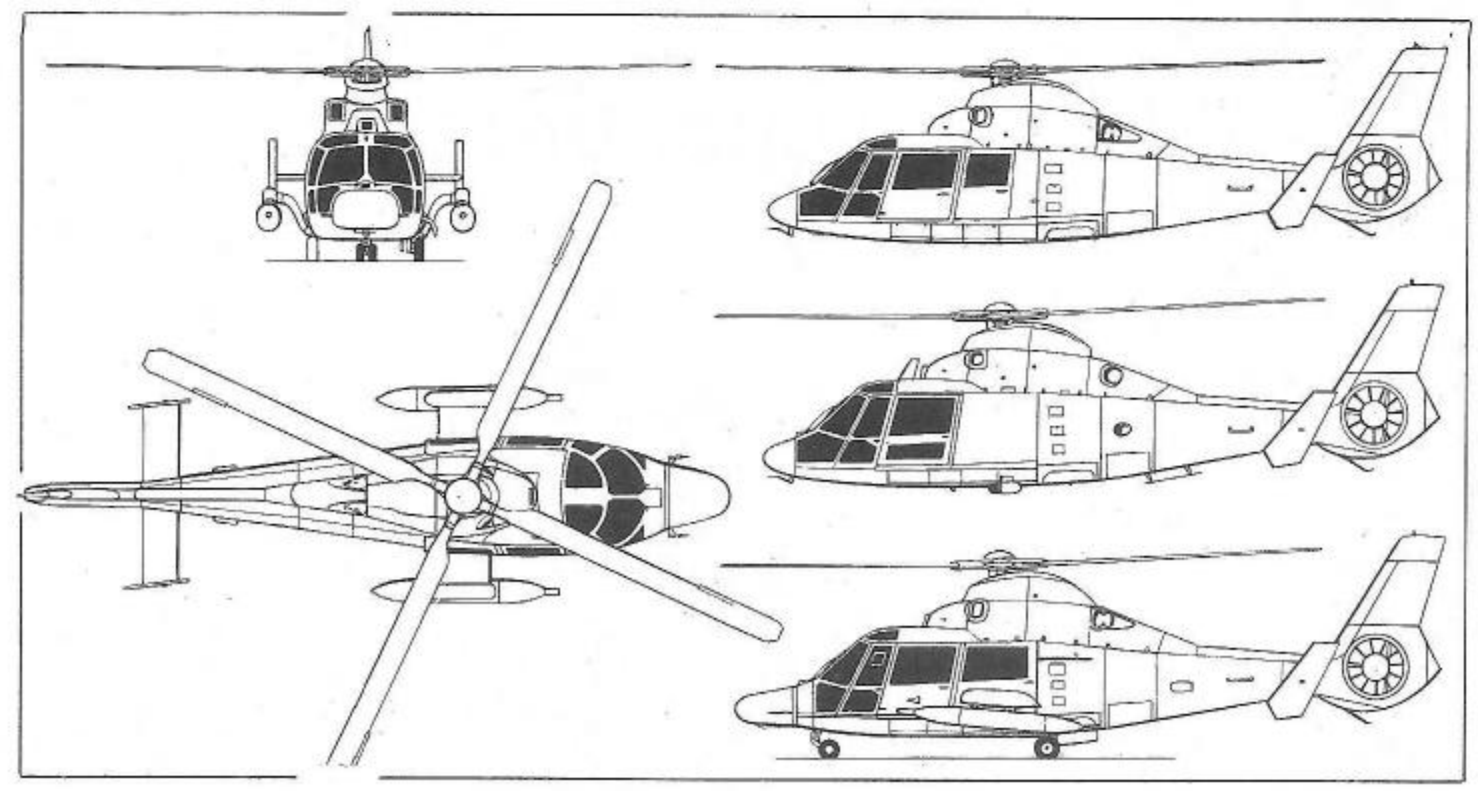
French Navy Eurocopter AS 565MA Panther on 'plane guard duties ('Pedro') (French Navy)

Dimensions
Main rotor:
diameter: 11.94 m (39.17 ft)
disc area: 111.97 m² (1,205.26 sq ft)
Fenestron:
diameter: 1.10 m (3.61 ft)
Fenestron area: 0.95 m² (10.23 sq ft)
Length, overall, rotor turning: 13.68 m (44.88 ft)
Length, fuselage: *12.11 m (39.73 ft)*
Height:
overall: 3.99 m (13.09 ft)
to top of rotor head: 3.52 m (11.55 ft)
Width over missiles: 4.20 m (13.78 ft)
Wheel track: 1.90 m (6.23 ft)
Wheelbase: 3.61 m (11.84 ft)

Weights
Weight, empty (standard aircraft): 2,262 kg (4,987 lb)
Max take-off weight: 4,250 kg (9,370 lb)

Radius of action, anti-shipping mission, 120 kts (222 km/h) cruising speed at 915 m (3,000 ft), ISA-20°C, 30 min reserves:
4 missiles: 135 n miles (250 km)
2 missiles: 150 n miles (278 km)
Radius of action, search and rescue, ISA+ 20°C, 30 min reserves, carrying six survivors: 130 n miles (241 km)
Range with max standard fuel at sea level: 472 n miles (874 km)

Performance (at average mission weight of 4,000 kg; 8,818 lb)
Never exceed speed (VNE): 160 kts (296 km/h)
Cruising speed at sea level: 148 kts (274 km/h)
Max rate of climb at sea level: 420 m (1,380 ft)/min
Hovering ceiling:
in ground effect: 2,600 m (8,530 ft)
out of ground effect: 1,860 m (6,102 ft)



Eurocopter AS565AA Panther with side view (top) of AS 365N2

Israeli Navy AS 565

Power plant: 2 Turbomeca Arriel 1M1 turboshafts, each giving 558 kW (749 shp) for take-off and 487 kW (653 shp) continuously
Fuel: Standard fuel capacity 1,135 litres (300 US gallons; 250 Imp gallons); optional 180 litres (47.5 US gallon; 39.6 Imp gallon) auxiliary tank
Accommodation: Pilot, co-pilot. The cabin can hold up to 10 passengers
Sensors: See 'Naval variants' (below)
Weapons: See 'Naval variants' (below)

FURTHER INFORMATION

PROGRAMME

A two-engined, multirole, military version of the AS 365 Dauphin, the AS 565 Panther is available in a number of naval versions, including the AS 565SA armed and AS 565MA unarmed/search and rescue types. The launch order was placed by Saudi Arabia in October 1980 and the first flight of a modified AS 365N (serving as the AS 565 prototype) was made in February 1982. The Dauphin/Panther employ the unique 'Fenestron', which, by completely shrouding the tail rotor, removes one of the main ground hazards of helicopter operations.

NAVAL OPERATORS

Abu Dhabi: Seven, with AS.15TT, ordered 1995 for employment aboard 'Muray Jib' (Lürssen 62) class fast-attack craft and 'Oliver Hazard Perry' class frigates.
China: The PLA-Navy operates about 50 HAMC Z-9A Haituns, which are embarked in 'Luhu', 'Luda II', 'Jianghu II' and 'Jiangwei' class destroyers/frigates.
France: The French Navy ordered three AS 565F (MA) in 1988 for employment as 'Pedros' (plane guards) with carriers *Clemenceau* and *Foch*. 15 more AS 565MAs are being delivered 1993-99, with an eventual requirement of 40. Some are employed for land-based search and rescue, but others go to sea embarked in 'La Fayette' class frigates.
Ireland: The Irish naval service ordered five for search and rescue duties, equipped with Bendix/King RDR 1500 radar, SFIM 155 autopilot, Sextant ONS 200A long-range navigation, Nadir Mk II navigation computer, Dassault Electronique Cina B Doppler and five-screen EFIS. These can also can carry light weapons, if required and operate from patrol vessel *Eithne.*
Israel: The search radar and navigation suite are by Elbit. They will operate from Sa'ar 5 frigates and up to 20 are required.
Saudi Arabia: The Saudi Navy ordered four SAR/surveillance AS 565MAs and 20 anti-ship AS 565SAs with AS 15TT. They will operate from Type 3000S (La Fayette) frigates.
Thailand: The Thai Navy has purchased nine HAMC Z-9A Haituns.

NAVAL VARIANTS

AS 565MA Panther: Unarmed naval search and rescue and sea surveillance version, fitted with a rescue hoist, sea search radar, self-contained navigation and automatic hover transition. Options include a searchlight and a deck-landing harpoon.
AS 565SA Panther: This is the armed ASW and anti-ship version. The ASW version has Sextant Avionique MAD or Thomson Sintra ASM HS 312 sonar and is armed with two homing torpedoes. For the anti-shipping role, a chin-mounted, roll-stabilised Agrion 15 radar is mounted and weapons consist of four side-mounted AS 15TT radar-guided missiles. Search and rescue versions have nose-mounted Omera ORB 32 search radar.
AS 565 Panter: Ordered by Israel Defence Force, April 1994, and will be outfitted in Israel on delivery.
HAMC Z-9A Haitun: Licence-built AS 365 Dauphin, manufactured in China. Sensors include Thomson-CSF Agrion, HS-12 dipping sonar, and Crouzet MAD. Weapons can include a maximum of four PRC-designed anti-ship missiles, Whitehead A224 torpedoes, or locally manufactured Mk 46 Mod 2 torpedoes.

French Navy AS 565SA Panther (Jane's/H M Steele)

SA 365F, with harpoon engaged in deck (Eurocopter/Aerospatiale)

EUROCOPTER (MBB) BO-105

AIRCRAFT

Type: Five/six-seat twin-turbine light helicopter

In naval service: Chile (9); Colombia (3); Indonesia (10); Mexico (12); Nigeria (12); Philippines (7)

SPECIFICATIONS

Dimensions
Main rotor:
diameter: 9.84 m (32.28 ft)
disc area: 76.05 m² (818.6 sq ft)
Tail rotor:
diameter: 1.90 m (6.23 ft)
disc area: 2.835 m² (30.5 sq ft)
Length:
including main and tail rotors: 11.86 m (38.91 ft)
excluding rotors: 8.81 m (28.90 ft)
fuselage pod: 4.55 m (14.93 ft)
Height to top of main rotor head: 3.02 m (9.91 ft)
Width over skids:
unladen: 2.53 m (8.30 ft)
laden: 2.58 m (8.46 ft)
Rear-loading doors:
height: 0.64 m (2.10 ft)
width: 1.40 m (4.59 ft)

PADC BO 105C, a locally assembled version of the Eurocopter BO 105; seven are operated by the Philippine Navy (Philippine Navy)

BO 105CB of the Colombian Navy (Colombian Navy)

Weights
Weight empty, basic: 1,301 kg (2,868 lb)
Max take-off weight: 2,500 kg (5,511 lb)
Standard fuel (usable): 456 kg (1,005 lb)
Max fuel, incl auxiliary tanks: 776 kg (1,710 lb)

Performance (at max take-off weight)
Never exceed speed (VNE) at sea level: 131 kts (242 km/h)
Max cruising speed at sea level: 129 kts (240 km/h)
Best range speed at sea level: 110 kts (204 km/h)
Max rate of climb at sea level, max continuous power: 444 m (1,457 ft)/min
Vertical rate of climb at sea level, take-off power: 90 m (295 ft)/min
Max operating altitude:
at 2,500 kg (5,511 lb): 3,050 m (10,000 ft)
at 2,300 kg (5,070 lb): 5,180 m (17,000 ft)
Hovering ceiling, take-off power:
in ground effect: 1,525 m (5,000 ft)
out of ground effect: 457 m (1,500 ft)
Range with standard fuel and max payload, no reserves:
at sea level: 300 n miles (555 km)
at 1,525 m (5,000 ft): 321 n miles (596 km)
Ferry range with auxiliary tanks, no reserves:
at sea level: 519 n miles (961 km)
at 1,525 m (5,000 ft): 550 n miles (1,020 km)
Endurance with standard fuel and max payload, no reserves, at sea level: 3 h 24 min
Power plant: 2–313 kW (420 shp) Allison 250-C20B turboshafts, each with a max continuous rating of 298 kW (400 shp)
Fuel: Bladder fuel tanks under cabin floor, usable capacity 570 litres (150.6 US gallons)
Accommodation: Pilot and co-pilot/passenger in front seats. Bench seat at rear for 3 persons
Avionics: Wide variety of avionics available incl weather radar, Doppler and GPS navigation, 360° search radar, FLIR, TV broadcast and microwave datalink

FURTHER INFORMATION

PROGRAMME

The first flight of the prototype took place on 16 February 1967 and was followed by the production of 100 BO 105 M (VBH) and 212 BO 105 P (PAH-1), these orders being completed in 1984. The type was also assembled by Eurocopter Canada and CASA in Spain, and manufactured by IPTN in Indonesia. By January 1995 1,329 BO 105s of all models had been delivered to 40 countries of which 53 were for six navies (see below).

NAVAL OPERATORS

Chile: The navy operates nine MBB BO-105C, which are used for coastal patrol, training and liaison duties, with search and rescue as a secondary role. They are fitted with a Bendix search radar, but are unarmed. They could be found on any warship fitted with a flight deck.
Colombia: Three MBB BO-105CB are employed for shipborne surface search and limited ASW duties. They are fitted with search/weather radar and can carry depth bombs or machine gun pods. They operate from the 'Almirante Padilla' class corvettes.
Indonesia: The Indonesian Navy operates ten MBB-105Cs, locally assembled by IPTN (Nusantara Aircraft Industries) under the designation NBO-105C, for shipborne liaison and support duties. Numbers are increasing slowly. They are equipped with Thomson-CSF Oceanmaster radar, but are normally unarmed. One particular platform is the frigate *Ki Hajar Dewantara*.
Mexico: The MBB-105 has been used for some years by the Mexican Navy for coastal patrol, fishery protection and EEZ protection, with search and rescue as a secondary role. For these tasks the helicopters are fitted with a Bendix search radar and armed with machine guns or rocket pods. They are being replaced by MD 900 Explorers from 1996 onwards.
Nigeria: The Nigerian Navy possesses 12 MBB BO-105C, which are used for onshore, coastal and inshore search and rescue missions. They may also be used for limited commando assault tasks and other fleet support duties. They have no sensors and are normally unarmed but could be provided with machine gun or cannon pods.
Philippines: The Philippine Navy currently has seven MBB BO-105C, which were assembled locally by PADC (Philippine Aerospace Development Corporation). These are the navy's only shipboard helicopters and operate from those LSTs fitted with flight decks. Some are fitted with search radar. They are unarmed.

Eurocopter BO 105 CB on the flight deck of a 'Holzinger' class gunship of the Mexican Navy (Eurocopter)

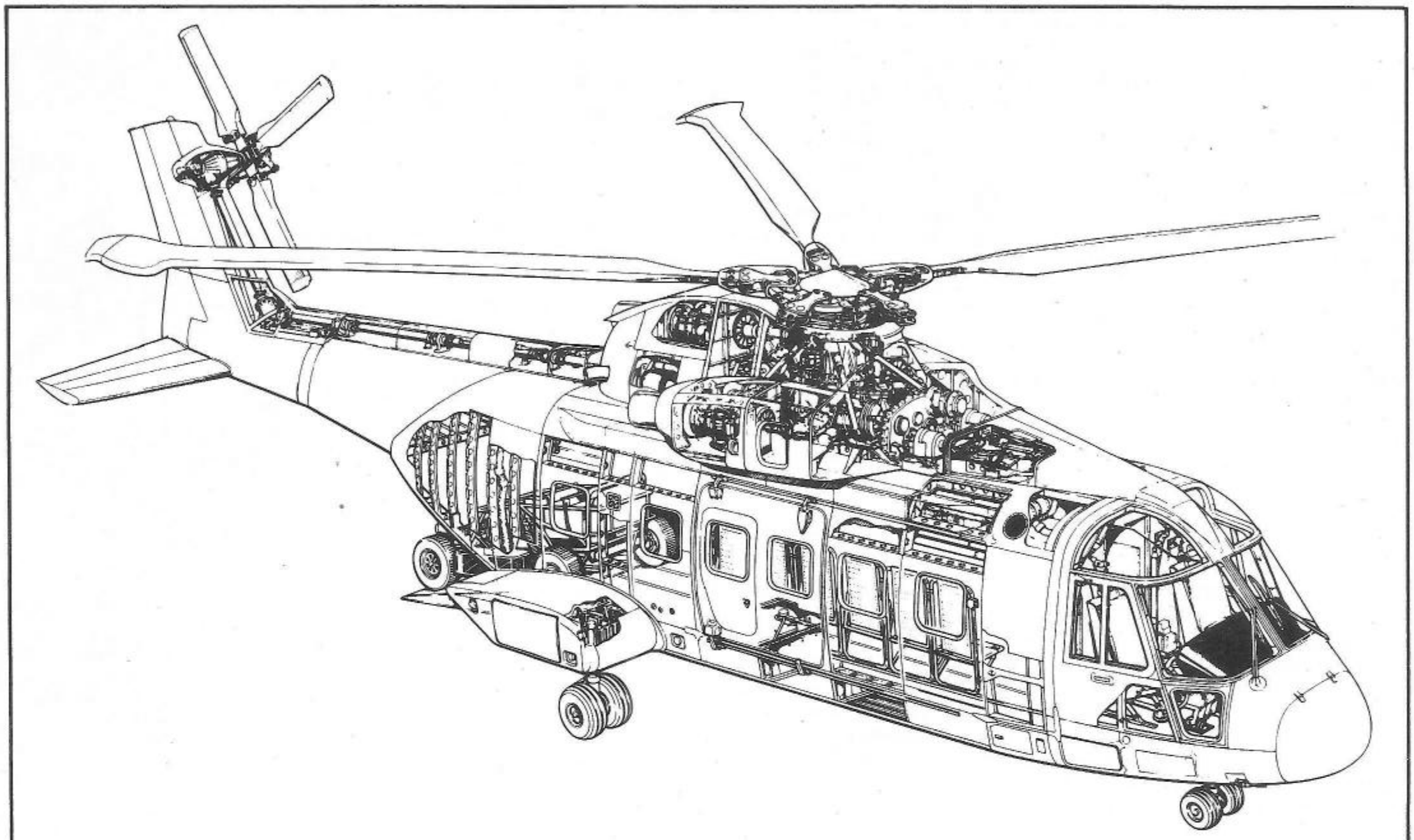
Chilean Navy BO 105C (Chilean Navy)

EUROPEAN HELICOPTERS INDUSTRIES EH 101 MERLIN

AIRCRAFT

Role: 3-engined shipboard anti-submarine helicopter

In naval service: UK (44); Italy (16)



EH 101 cutaway drawing (EH Industries)

SPECIFICATIONS

All details apply to naval variant
Dimensions
Main rotor diameter: 18.59 m (61.0 ft)
Length:
overall, both rotors turning: 22.81 m (74.83 ft)
main rotor, tail pylon folded: 16.00 m (52.5 ft)
Width:
excl main rotor: 4.52 m (14.81 ft)
main rotor, tail pylon folded: 5.49 m (18.0 ft)
Height:
overall, both rotors turning: 6.65 m (21.81 ft)
main rotor, tail pylon folded: 5.21 m (17.08 ft)
Main rotor disc area: 271.51 m² (2,922.5 sq ft)

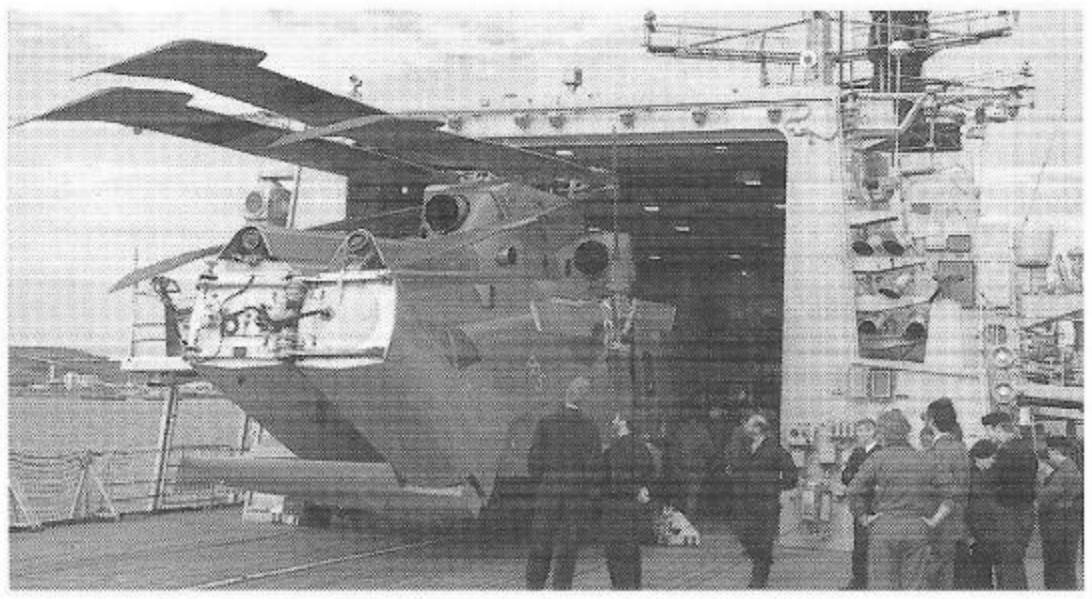
Weights
Operating weight empty (estimated): 10,500 kg (23,149 lb)
Max fuel (4 internal tanks): 3,406 kg (7,509 lb)
Disposable load/payload (4 torpedoes): 960 kg (2,116 lb)
Max take-off weight: 14,600 kg (32,188 lb)

Performance
Never exceed speed (sea level) (ISA): 167 kts (309 km/h)
Average cruising speed: 150 kts (278 km/h)
Best range cruising speed: 140 kts (259 km/h)
Best endurance speed: 90 kts (167 km/h)

Power plant
British Navy version: 3 Rolls-Royce Turbomeca RTM 322 turboshafts; max contingency and intermediate contingency ratings 1,724 kW (2,312 shp) and 1,566 kW (2,100 shp), respectively
Italian Navy version: 3 General Electric T700-GE-T6A turboshafts rated at 1,278 kW (1,714 shp) max contingency, 1,254 kW (1,682 shp) intermediate and 1,071 kW (1,437 shp) max continuous at sea level, ISA
Accommodation: pilot, observer and acoustic systems operator, with Martin-Baker crew seats able to withstand 10.7 m (35 ft)/s impact

Avionics
Integrated systems based on 2 MIL-STD-1553B multiplex databuses linking basic aircraft management, avionics and mission systems
Communications: ASW version has Elmer HF (2), and GEC-Marconi UHF (1) and AD 3400 V/UHF (2) com radios
Radar: ASW version fitted with 360° search radar (GEC-Marconi Blue Kestrel in UK's Merlin; Eleradas

EH 101 touches down on the flight deck of Type 23 frigate, HMS Norfolk (Westland)



The hangar of the British Type 23 frigate can accommodate the EH 101 with ease (Westland)

EH 101 prototype lands on the flight deck of Type 23 frigate, HMS Iron Duke (Westland)

MM/APC-784 in Italian helicopters)

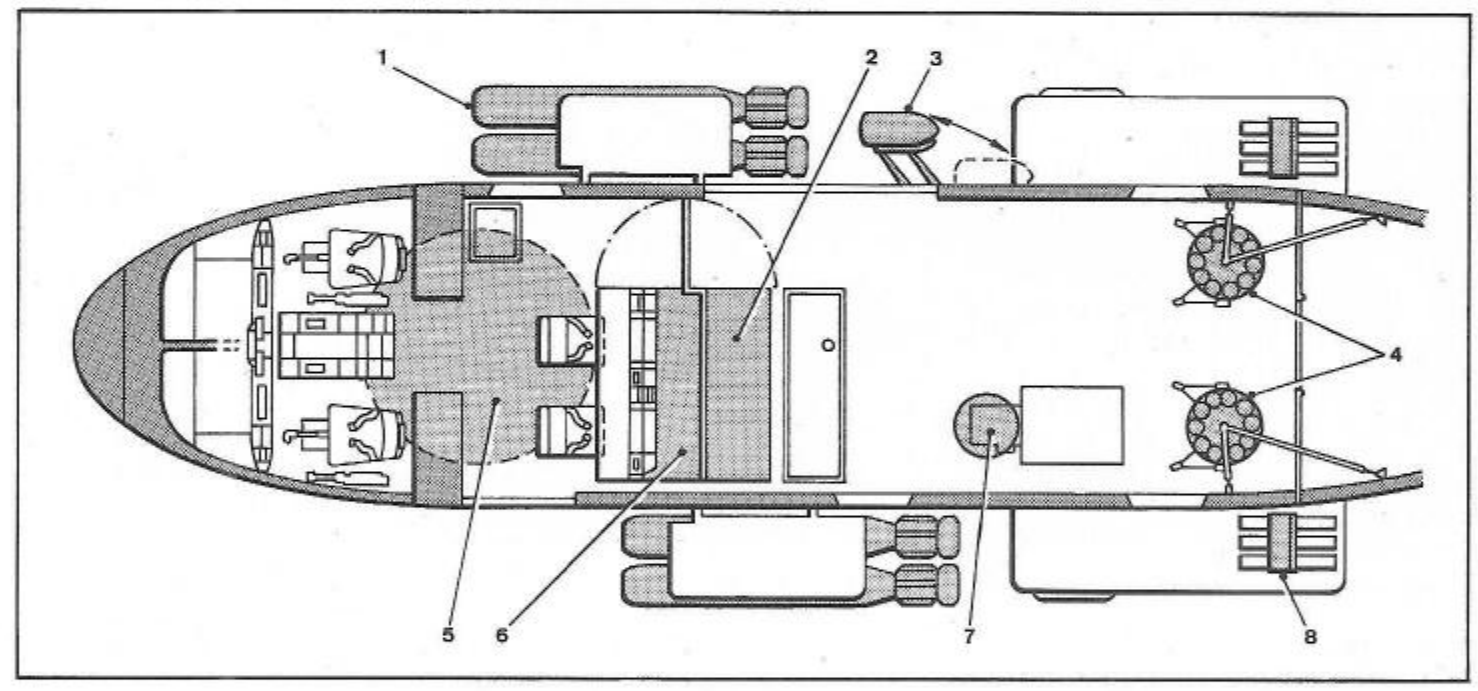
Flight: Smiths Industries OMI SEP 20 dual-redundant digital AFCS is standard, providing fail-operational autostabilisation and 4-axis autopilot modes (auto hover, auto transitions to/from hover standard. AFCS sensors on naval variant include British Aerospace LINS 300 ring laser gyro inertial reference unit (IRU) and Litton Italia LISA-4000 strapdown AHRS; IRU also provides self-contained navigation, with Racal Doppler 91E velocity sensor; Cossor Electronics GPS receiver selected for British Navy variant, Euronav GPS for Italian Navy aircraft. Other avionics on naval variants include Thomson-CSF AHV 16 radar altimeters (2), GEC-Marconi low-airspeed sensing and air data system, and Alenia/GEC-Marconi aircraft management computer

Mission

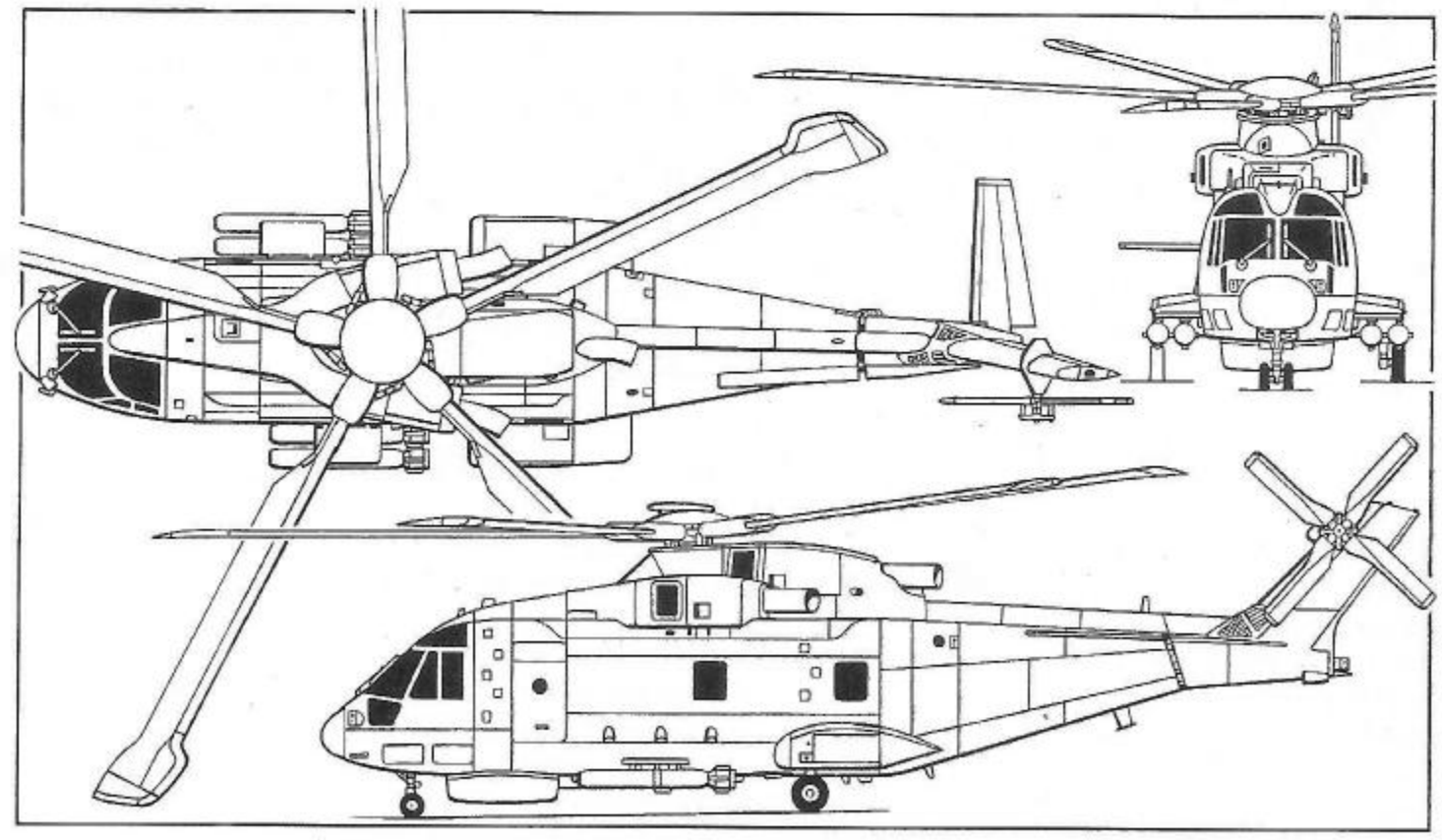
On the naval variant, the main processing element of the management system is a dual-redundant aircraft management computer which carries out navigation, control and display management, performance computation and health and usage monitoring of principal systems (engines, drive systems, avionics and utilities); it also controls the basic bus. Alenia/Racal cabin mission display unit. Surveillance radar (see above), plus dipping sonar (GEC-Thomson/Sintra folding lightweight acoustic system for helicopters, FLASH, in Merlin), advanced sonobuoy processing equipment and Racal Orange Reaper ESM. Alenia SL/ALR-735 ASM for Italy. GEC-Marconi AQS-950 acoustic processing system, NGL mission recorder and sonobuoy/flare dispenser, and Chelton sonobuoy homers, in Merlin. Alenia AYK-204 processors (4) in Italian version. ASST (anti-ship surveillance and tracking) version will carry equipment for tactical surveillance and OTH (over-the-horizon) targeting, to locate and relay to a co-operating frigate the position of a target vessel, and for mid-course guidance of frigate's missiles. On missions involving patrol of an exclusive economic zone it can also, with suitable radar, monitor every hour all surface contacts within an area of 77,700 km² (30,000 sq miles); can patrol an EEZ 400 × 200 n miles (740 × 370 km; 460 × 230 miles) twice in one sortie; and can effect boarding and inspection of surface vessels during fishing protection and anti-smuggling missions

Equipment

ASW variants will have 2 sonobuoy dispensers, external rescue hoist and Fairey Hydraulics (Merlin) decklock. BAJ Ltd 4-float emergency flotation gear



Typical ASW layout for EH 101
1 *up to four homing torpedoes;* **2** *sensor processing;* **3** *retractable rescue hoist;* **4** *sonobuoy dispensers;* **5** *360° radar;* **6** *mission console;* **7** *active dipping sonar;* **8** *light stores carriers* (Jane's/Mike Keep)



Naval EH 101 (Jane's/Mike Keep)

Armament

ASW version: Max of 4 homing torpedoes (probably Marconi Sting Ray on British version); or Eurotorp or A244; (Italian version). Also Marte Mk 2 ASM for Italian Navy. Other weapons, as appropriate

FURTHER INFORMATION

PROGRAMME

The British Navy selected the Westland WG-34 as its Sea King replacement in 1978, but then it was discovered that the Italian Navy had a broadly similar requirement and a joint venture was formalised with Agusta in 1980. Full programme go-ahead was announced on 25 January 1984, followed by a design and development contract signed on 7 March 1984.

The EH 101 was also selected as a CH-46 replacement by the Canadian Government in August 1987.

NAVAL VARIANTS

The naval version (Series 100) has primary roles of ASW, ASV, anti-ship surveillance/tracking, amphibious operations and SAR, while other roles may include AEW, vertrep and ECM (deception, jamming and missile seduction). The EH 101 is designed for fully autonomous all-weather operation from land bases, large and small vessels (including merchant ships) as well as oil rigs. A specific requirement is the ability to operate from a 3,500 tonne frigate, with dimensions tailored to frigate hangar size and launch and recovery taking place in conditions up to Sea State 6, with the ship on any heading and windspeed (from any direction) up to 50 knots (93 km/h). Endurance and carrying capacity are tailored to meet expanding maritime tactical requirements of 21st century, including the ability to operate for up to five hours with state-of-the-art equipment and weapons. Nine prototypes were ordered, of which the first (PP01) flew in the UK in 1987 followed by PP02 in Italy a month later.

UK orders currently total 66, of which 44 are for the navy, at a cost of £1.5 billion (at 1991 prices). These will operate from Type 23 frigates, 'Invincible' class carriers, Royal Fleet Auxiliaries and other ships, as well as land bases. The balance of the UK order — 22 aircraft — is for the air force at a cost of £500 million (also at 1991 prices). The Italian Navy is expected to order an initial 16, comprising eight ASW (and ASV) versions, four AEW versions and four marine tactical transports with blade- and tail-folding. These will operate from the carrier *Giuseppe Garibaldi* and possibly also from the 'De La Penne' class destroyers. An option is anticipated on a further eight, configuration unspecified. A long-range utility version for logistic and tactical support role is also under consideration by Italy and has been proposed to the US Marine Corps.

A Merlin upgrade is already under study, which would involve improved sensors and processing equipment, plus uprated transmission for later versions of RTM 322. This would be retrofitted to completed aircraft as well as applied to new builds.

DESIGN

Main features of the design are three engines to give a large margin of power; fail-safe/damage-tolerant airframe and rotating components, high system redundancy, onboard monitoring of engines/transmission/avionics/utility systems; airframe/power plant/rotor and transmission systems/flight controls/utility systems common to all variants; five-blade main rotor with multiple load path hub and elastomeric bearings; blades of advanced aerofoil section with BERP-derived high-speed tips; four-blade teetering tail rotor; transmission has minimum 30 minutes (60 minutes demonstrated) run-dry capacity; fuselage in four main modules (front and centre ones common to all variants, modified rear fuselage and slimmer tailboom on military utility variant to accommodate rear-loading ramp); automatic power folding of main rotor blades and tail rotor pylon on naval variant, with emergency manual back-up (tail section folds forward/downward, stowing starboard half of tailplane beneath rear fuselage). Folding version of utility (rear ramp) EH 101 has been designed. New active vibration cancelling system ACSR (active control of structural response) reduces vibration by 80 per cent at blade passing frequency. Airframe overhaul interval 1,000 hours on service entry; eventual target 3,000 hours. Intended service life of 40,000 hours.

The Italian-built ninth prototype EH 101 (EH Industries)

Stingray torpedo under EH 101 weapons carrier prior to loading (Westland)

KAMOV Ka-25 (NATO = HORMONE)

AIRCRAFT

Role: Twin-turbine multipurpose military helicopter

In naval service: India (?); Russia (88); Syria (3); Vietnam (3); former Yugoslavia (7)

SPECIFICATIONS

Dimensions (Ka-25PL)
Rotors:
diameter (each): 15.74 m (51.64 ft)
disc area (each): 194.6 m² (2,095 sq ft)
Length of fuselage: 9.75 m (32.0 ft)
Height to top of rotor head: 5.37 m (17.62 ft)
Width over tailfins: 3.76 m (12.33 ft)
Wheel track:
front: 1.41 m (4.63 ft)
rear: 3.52 m (11.55 ft)
Cabin door:
height: 1.10 m (33.61 ft)
width: 1.20 m (3.94 ft)

Weights
Operating weight, empty: 4,765 kg (10,505 lb)
Max take-off weight: 7,200 kg (15,873 lb)

Performance
Max level speed: 113 kts (209 km/h; 130 mph)
Normal cruising speed: 104 kts (193 km/h; 120 mph)
Service ceiling: 3,350 m (11,000 ft)
Range, with reserves:
standard fuel: 217 n miles (400 km)
external tanks: 351 n miles (650 km)

Power plant
Early aircraft: 2 Mars (Glushenkov) GTD-3F turboshafts, each rated at 662 kW (888 shp), located side by side above the cabin, forward of rotor driveshaft
Later aircraft: 2—735 kW (986 shp) GTD-3M turboshafts

Fuel: Independent fuel supply to each engine. Provision for external fuel tank each side of cabin
Accommodation: Pilot and co-pilot side by side on flight deck, with rearward-sliding door each side. Rearward-sliding door to rear of main landing gear on port side. Up to 12 folding seats for passengers (optional)
Sensors: Equipment available for all versions includes autopilot, radio, navigation system, radio compass, lighting for all-weather operation by day or night, and a

Ka-25 of the Russian Navy

Kamov Ka-25T (NATO = Hormone-B) over-the-horizon target acquisition helicopter with special electronics

hoist above the cabin door. IFF antennas (NATO 'Odd Rods') are normally installed above the nose and alongside the central tailfin. OKA-2 dipping sonar is installed in a compartment at the rear of main cabin, immediately forward of tailboom, and the search radar (NATO = 'Short Horn') is in a flat-bottomed undernose radome (diameter 1.25 m; 4.08 ft) on Ka-25PL. This type can also have a canister of sonobuoys mounted externally aft of starboard main landing gear. Most aircraft have cylindrical housing for an ESM antenna above the tailboom, a shallow blister fairing to the rear of the cylindrical ESM housing, and a similar housing under the rear of the cabin for datalink to the parent ship

Weapons: Doors under fuselage of some aircraft enclose weapons bay for 450 mm (1.5 ft) ASW torpedo

FURTHER INFORMATION

PROGRAMME

The prototype of this very successful and unusual design first flew in 1961 and was shown during the Soviet Aviation Day flypast at Tushino Airport, Moscow, in July of that year. In that flypast it carried two dummy air-to-surface missiles, although these were not fitted to production aircraft. About 460 were built between 1966 and 1975, of which 88 remain operational with the Russian Navy. The Ka-25 has been exported in some numbers.

NAVAL OPERATORS

Russia: The Ka-25 is being replaced by Ka-27 (NATO = Helix), but approximately 88 remain in service and may be found on any warship with helicopter facilities.

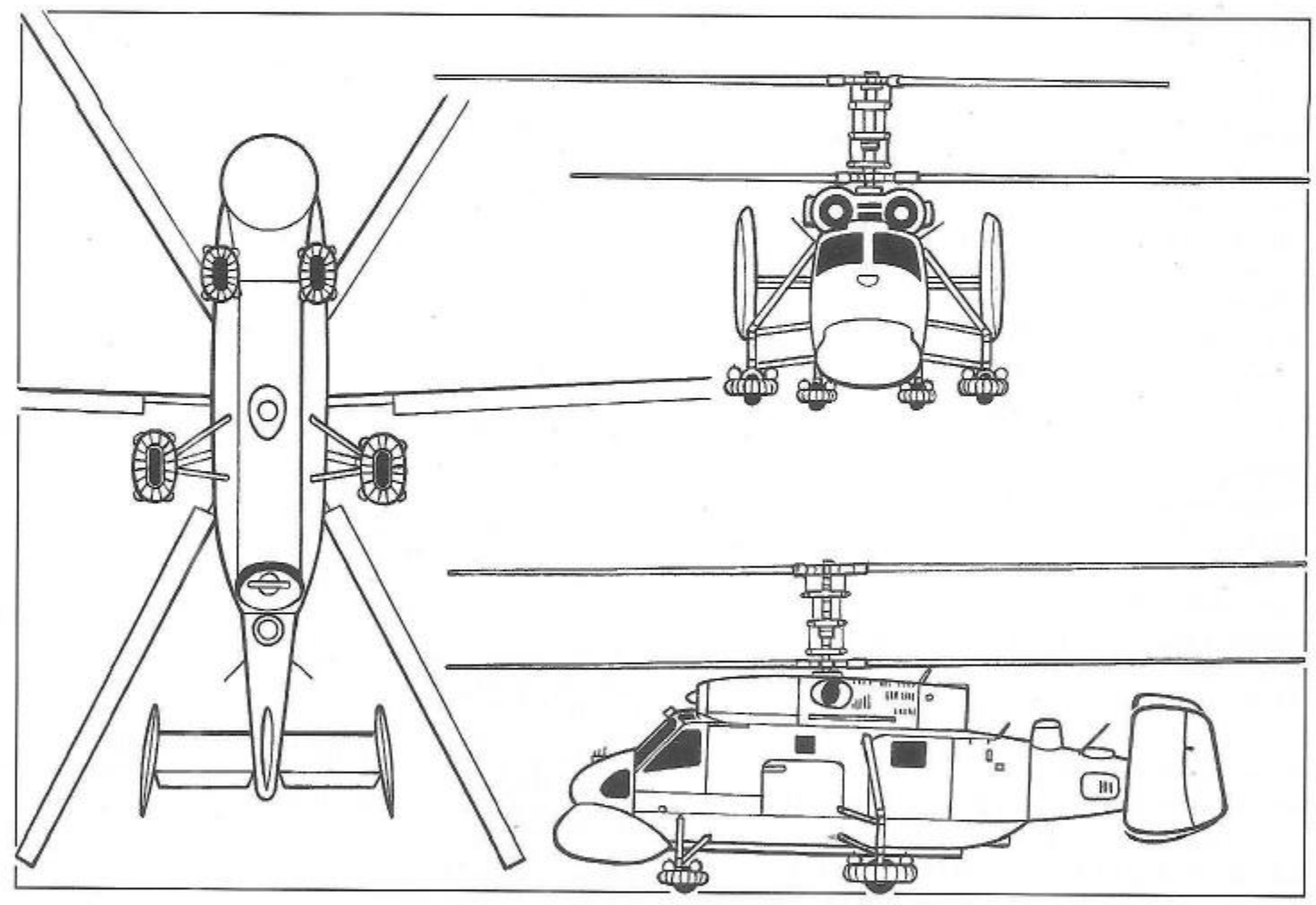
India, Syria, Vietnam: A number was supplied to the Indian Navy, of which some undoubtedly survive, althoug they have, almost certainly, been replaced at sea by Ka-27 (NATO = Helix). Others were supplied to Syria (3), Vietnam (3) and the former Yugoslavia (7) but are land-based.

NAVAL VARIANTS

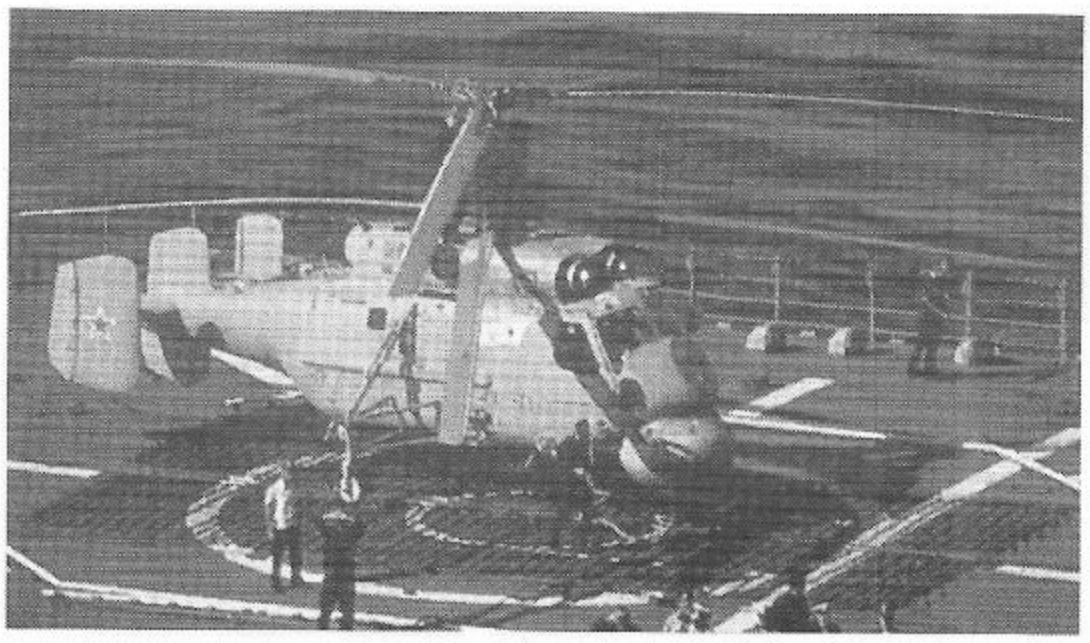
Four major variants are in service:

Ka-25PL *(protivolodochny)* (NATO = 'Hormone-A'): Shipborne anti-submarine helicopter, equipped with surveillance radar and dipping sonar, and sometimes armed with one torpedo in a long, under-fuselage bin.

Ka-25Ts *(tseleukazatel)* (NATO = 'Hormone-B'): This is a special electronics variant, providing over-the-horizon target acquisition for cruise missiles launched from ships on which it is based. It has a larger undernose radome (NATO = 'Big Bulge') than the Ka-25PL, with spherical undersurface. There is also a cylindrical



Kamov Ka-25PL (Hormone-A)



KA-25 aboard 'Kirov' class cruiser, Frunze (*now,* Admiral Lazarev) (US DoD (SMP))

Kamov Ka-25PL (NATO = Hormone-A) anti-submarine helicopter of Russian Naval Aviation

radome under the rear cabin for missile mid-course guidance and the helicopter-to-ship datalink; when radar operates, all landing gear wheels can retract upward to minimise interference to emissions. There is also a cylindrical fuel container each side of lower fuselage.

Ka-25BShZ: This is equipped to tow minesweeping gear and is externally similar to the Ka-25PL, but without sonar.

Ka-25PS (NATO = 'Hormone-C'): Search and rescue version, with special role equipment, including hoist.

DESIGN

This aircraft has the unique Kamov system, consisting of two contrarotating, coaxial, three-bladed rotors, which cancel each other's torque, with directional stability being provided by three large tailfins. This results in a lighter and simpler design than if a tail rotor is used, although the rotor head, which incorporates blade-folding, is somewhat complex.

The lower part of the fuselage is sealed, but if it is thought that flotation will be necessary, special inflatable bags are fitted to the undercarriage legs.

KAMOV Ka-27/Ka-28/Ka-32 (NATO = HELIX-A,-C,-D)

AIRCRAFT

Role: Twin-turbine multipurpose military helicopter

In naval service: India (17+); Russian (88); Ukraine (2-3); former Yugoslavia (10)

SPECIFICATIONS

Dimensions
Rotors:
diameter (each): 15.90 m (52.17 ft)
disc area (each): 198.5 m² (2,138 sq ft)
Length overall:
excluding rotors: 11.30 m (37.07 ft)
rotors folded: 12.25 m (40.19 ft)
Width, rotors folded: 4.00 m (13.12 ft)
Height to top of rotor head: 5.40 m (17.72 ft)
Wheel track:
mainwheels: 3.50 m (11.5 ft)
nosewheels: 1.40 m (4.59 ft)
Wheelbase: 3.02 m (9.91 ft)
Cabin door:
height: 1.20 m (3.94 ft) (approx)
width: 1.20 m (3.94 ft) (approx)

Weights
Weight empty: 6,500 kg (14,330 lb)
Max payload:
internal: 4,000 kg (8,818 lb)
external: 5,000 kg (11,023 lb)
Normal take-off weight: 11,000 kg (24,250 lb)
Max flight weight with slung load: 12,600 kg (27,775 lb)

Performance (Ka-28)
Max level speed at 10,700 kg (23,590 lb) AUW: 145 kts (270 km/h; 168 mph)
Max cruising speed: 124-129 kts (230-240 km/h)
Max rate of climb at sea level: 750 m (2,460 ft)/min
Radius of action against submarine cruising at up to 40 kts (75 km/h; 47 mph) at depth of 500 m (1,640 ft): 108 n miles (200 km)

Power plant: 2—1,633 kW (2,190 shp) Klimov TV3-117V (Ka-32) or TV3-117VMA (Ka-32A) turboshafts, with automatic synchronisation system, side by side above cabin, forward of rotor driveshaft. Main gearbox brake standard
Fuel: Tanks under cabin floor and inside container each side of centre-fuselage; capacity of main tanks 2,180 litres (576 US gallons); max capacity with 2 underfloor auxiliary tanks 3,000 litres (792 US gallons)
Accommodation: Crew of 3; pilot, tactical co-ordinator, ASW systems operator

Avionics
Communications: IFF (NATO 'Odd Rods')
Flight: Include electromechanical flight director controlled from autopilot panel, Doppler hover indicator, 2 HSI and air data computer. Fully coupled 3-axis autopilot can provide automatic approach and hover at height of 25 m (82 ft) over landing area, on predetermined course, using Doppler. Radar altimeter. Doppler box under tailboom
Radar: Undernose 360° search radar; directional ESM radomes above rear of engine bay fairing and at tail-cone tip

Mission
Dipping sonar behind clamshell doors at rear of fuselage pod; sonobuoys stowed internally. MAD. Doppler box under tailboom

Self-Defence
Radar warning receiver (RWR) on nose and above tailplane; infra-red jammer (NATO = Hot Brick) at rear of engine bay fairing; station-keeping light between ESM radome and jammer; chaff/flare dispensers; colour coded identification flares

Armament
Ventral weapons bay for torpedoes, depth charges, other stores

Kamov Ka-27 (NATO = Helix-A) of the Indian fleet air arm (SIRPA-Air)

FURTHER INFORMATION

PROGRAMME

Despite its many strong points, the Ka-25 proved unable to operate dipping sonar at night and in adverse weather, so work on a new design began in 1969, with the first flight of the prototype taking place in 1973. The outcome is the Kamov Ka-27, a helicopter with similar overall dimensions to the Ka-25 and thus requiring a similar amount of deck space, and able to use the same hangars and elevators. It does, however, have much more powerful engines, more efficient rotors and much greater usable fuselage volume, although it has only two tailfins to the Ka-25's three. The aircraft was first seen by Western observers in September 1981 aboard the *Sovremenny* and then, in 1983, at least 16 were observed aboard the 'Kiev' class carrier, *Novorossiysk*. Since then the type has entered service with the Russian Navy in large numbers and export models have been sold to India and former Yugoslavia.

The Ka-32 was developed, concurrently with the Ka-27, for the civil market. However, at least one subtype of this version, the Ka-32S, appears to be in use as a shipborne search and rescue helicopter for the Russian Navy.

NAVAL VARIANTS

Ka-27PL (NATO = Helix-A): This is the basic ASW helicopter with three crew, which has been operational since 1982. The aircraft normally operate in pairs, with one tracking the hostile submarine, while the other drops depth charges. Russian Naval Aviation has 88 and the navy of the Ukraine has 2 to 3, resulting from the split-up of the Black Sea Fleet assets.
Ka-27PS (NATO = Helix-D): This is a search and rescue and plane guard helicopter. It is essentially similar to the Ka-27PL, but with some operational equipment

Kamov Ka-27PL (NATO = Helix-A) of the Russian Navy (Fotokhronika TASS)

Kamov Ka-27 (NATO = Helix-A) of the Indian fleet air arm

deleted. There is one external fuel tank on each side of the cabin, as in the civil Ka-32, and a winch above port cabin door.

Ka-28 (NATO = Helix-A): This is the export version of the Ka-27PL, which is reported by Yugoslav sources to have 1,618 kW (2,170 shp) TV3-117BK turboshafts and 3,680 kg (8,113 lb) of fuel in 12 tanks.

Ka-32S (NATO = Helix-C): This is a maritime version of the civil Ka-32, which has more comprehensive avionics than the basic Ka-32, including undernose radar, for IFR operation from ships. A 300 kg (661 lb) electric load hoist is standard. Duties with the merchant fleet include ice patrol, guiding ships through icefields, unloading and loading ships (up to 30 tonnes an hour, 360 tonnes a day). It also conducts naval search and rescue and helicopters of this type, in Aeroflot livery, have been seen operating from Russian Navy warships.

KAMOV Ka-29/KAMOV Ka-31 (NATO = HELIX-B)

AIRCRAFT

Type: Twin-turbine naval assault transport (Ka-29) and electronic warfare (Ka-31) helicopter

In naval service: Russia — Ka-29 (30+); Ka-31 ('a few')

SPECIFICATIONS

Dimensions
Rotors:
diameter (each): 15.90 m (52.16 ft)
disc area, each: 198.5 m² (2,138 sq ft)
Length, excl noseprobe, rotors: 11.30 m (37.07 ft)
Height overall: 5.40 m (17.72 ft)
Width:
between centrelines of outboard pylons: 5.65 m (18.54 ft)
over tailfins and centred rudders: 3.65 m (12.0 ft)

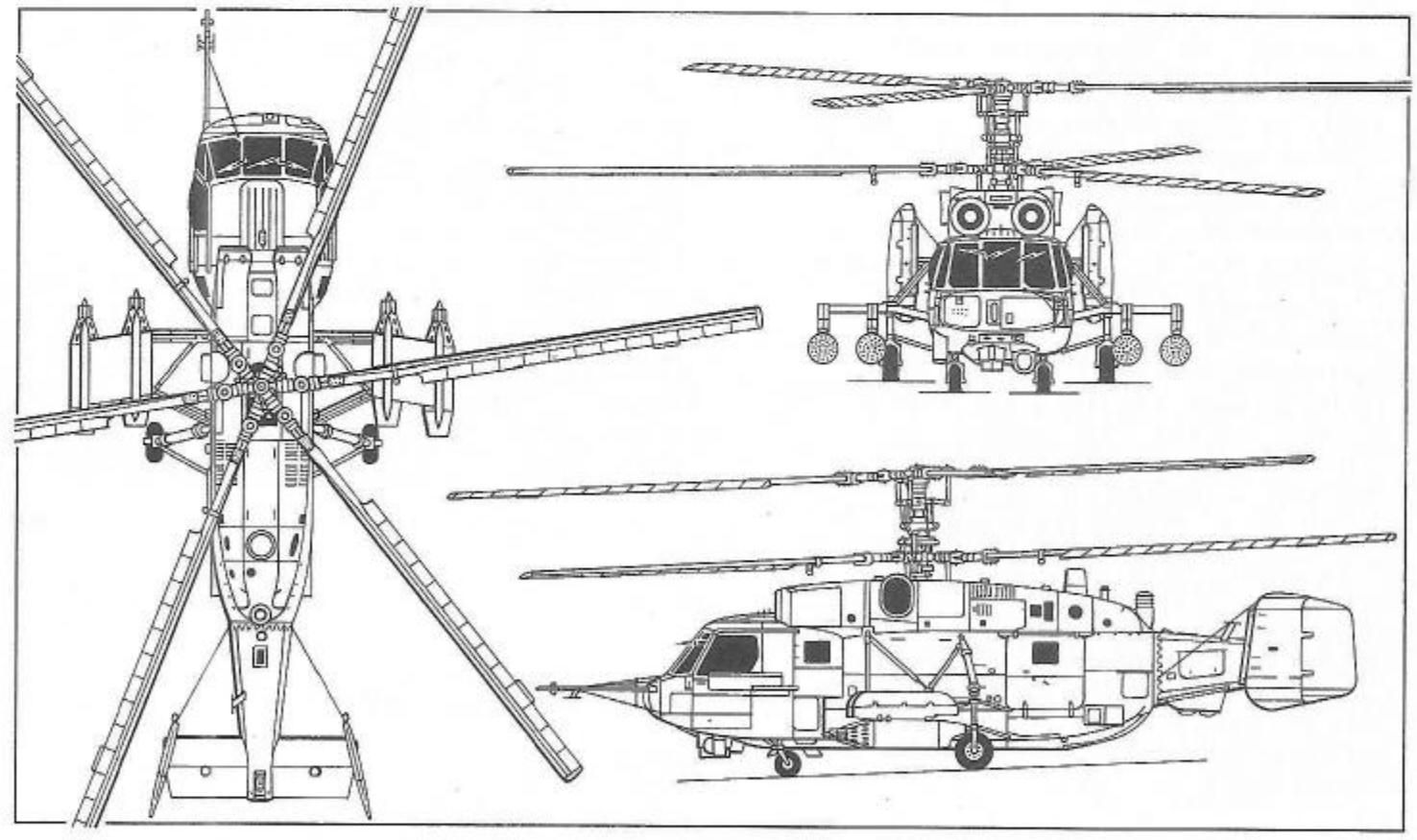
Weights
Empty: 5,520 kg (12,170 lb)
Max load:
internal: 2,000 kg (4,409 lb)
external: 4,000 kg (8,818 lb)
Normal take-off: 11,000 kg (24,250 lb)
Max take-off: 12,600 kg (27,775 lb)

Performance
Max level speed at sea level: 151 kts (280 km/h)
Nominal cruising speed: 127 kts (235 km/h)
Max rate of climb at sea level: 930 m (3,050 ft)/min
Service ceiling: 4,300 m (14,100 ft)
Hovering ceiling OGE: 3,700 m (12,140 ft)
Combat radius (6-8 attack runs): 54 n miles (100 km)
Range:
max standard fuel: 248 n miles (460 km)
ferry: 400 n miles (740 km)

Power plant: 2 Klimov (Isotov) TV3-117V turboshafts, each 1,633 kW (2,190 shp)

Accommodation
Ka-29: pilot, co-pilot, plus 16 assault troops or 4 wounded on stretchers or 6 sitting casualties
Ka-31: pilot, co-pilot, gunner

Avionics
Flight: Doppler box under tailboom; IFF ('Slap Shot')



Kamov Ka-29 combat transport helicopter (Jane's/Mike Keep)

Kamov Ka-29 (Helix-B) of the Indian Navy aboard destroyer Ranvijay *(D 55)*

Mission
Undernose sensor pods appear similar to electro-optics and RF missile guidance pods of Mil Mi-24V; ESM 'flower pot' above rear of engine bay fairing

Self-Defence
Infra-red jammer (NATO 'Hot Brick'); station-keeping light between ESM and jammer; radar warning receivers

Armament
Ka-29: 4-barrel Gatling-type 7.62 mm machine gun, with 1,800 rds, flexibly mounted behind downward-articulated door on starboard side of nose. 4 pylons on outriggers, for 2–4-round clusters of 9M114 Shturm (AT-6 'Spiral') air-to-surface missiles and 2–57 or 80 mm rocket packs. Alternative loads include 4 rocket packs, 2 pods each containing a 23 mm gun and 250 rounds, or 2–ZB-500 incendiary tanks. Provision for 30 mm Type 2A42 gun above port outrigger, with ammunition feed from cabin
Ka-31: None

FURTHER INFORMATION

PROGRAMME

The Kamov Ka-29 entered service with the Northern and Pacific Fleets in 1985 and was photographed aboard the assault ship *Ivan Rogov* in the Mediterranean in 1987. Western observers thought the helicopter to be the Ka-27B and, as a result, it was given the NATO reporting name 'Helix-B'. It was, however, subsequently identified at the Frunze (Khodinka) air show, held in Moscow in August 1989, as a distinct type with its own designation: Kamov Ka-29 combat transport.

Another version, the Kamov Ka-31 radar picket, completed initial shipboard trials on aircraft carrier *Kuznetsov* (then *Tbilisi*) in 1990; both versions are expected to equip this ship.

NAVAL VARIANTS

Ka-29 (NATO = 'Helix-B'): A development of Ka-27 for transport and close support of seaborne assault troops. This has a wider flight deck than the Ka-27 with three flat-plate windscreen glazings instead of the earlier two-piece curved transparency, accommodating a flight crew of three. The new crew member is the gunner, who sits centrally on the flight deck to control the various weapons carried. The flight deck and engine bay are both heavily armoured. The main cabin port-side door, aft of the landing gear, is divided horizontally into upward- and downward-opening sections, to facilitate rapid exit of up to 16 assault troops. In the ambulance role, the Ka-29 can take four stretcher patients or six seated casualties.

Ka-31: Formerly designated the Ka-29RLD (*radiolokatsyonnogo dozora*), this is the first radar picket helicopter for the Russian Navy. It first flew in 1988 and two examples were seen on the aircraft carrier *Kuznetsov* in early 1992. The aircraft has the basic airframe of the Ka-27, but the package of special avionics includes a very large NIIR rotating radar antenna (area 6.0 m² (64.5 sq ft)), which is carried stowed flat against the underfuselage until it is required, when it deploys downward, turning through 90° into the vertical plane before starting to rotate. At the same time, the landing gear retracts upward to prevent interference.

The maximum surveillance radius is reported to be some 54 to 81 n miles (100 to 150 km) for fighter-size targets and 135 n miles (250 km) for surface vessels, with up to 20 targets tracked simultaneously. Crew of two. Endurance on station 2 hours 30 minutes at 3,500 m (11,500 ft).

Kamov Ka-29 (NATO = Helix-B) combat transport helicopter of the Russian Navy (Linda Jackson)

Kamov Ka-31 radar picket, with radar deployed and undercarriage retracted

WESTLAND WASP HAS Mk 1

AIRCRAFT

Role: Five-seat general purpose naval helicopter

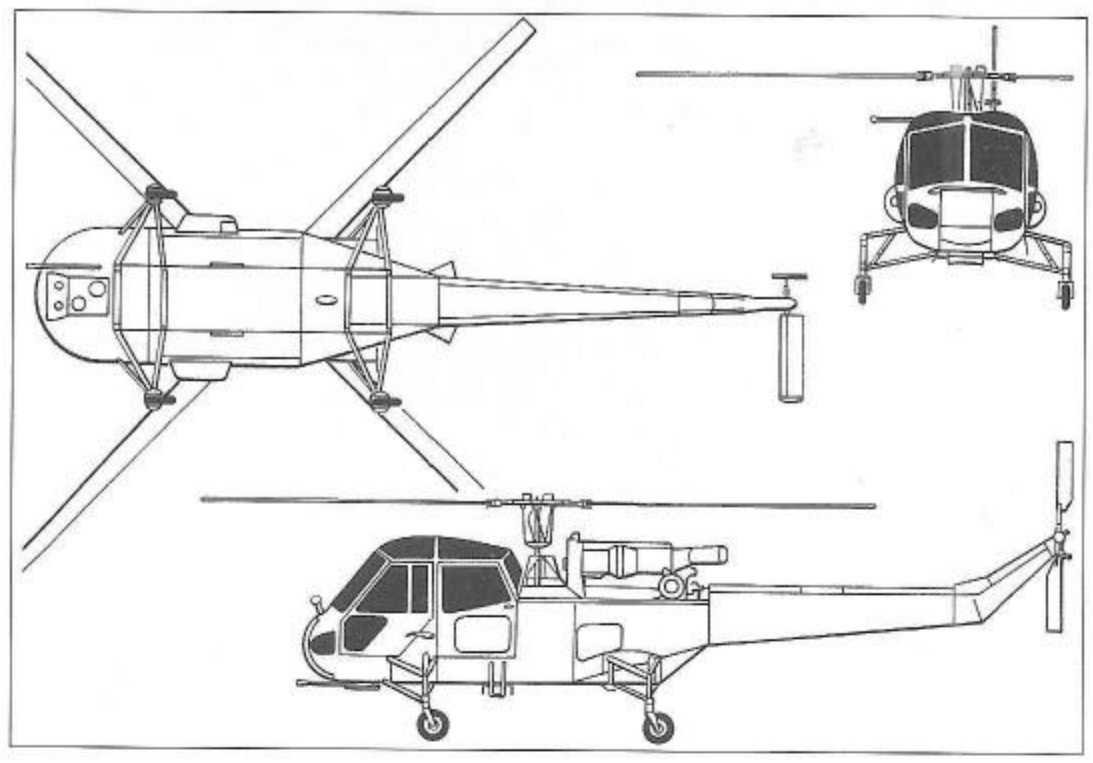
In naval service: Indonesia (9); Malaysia (6); New Zealand (5)

SPECIFICATIONS

Dimensions
Main rotor
diameter: 9.83 m (32.25 ft)
disc area: 75.90 m² (816.86 sq ft)

Tail rotor
diameter: 2.29 m (7.5 ft)
disc area: 4.10 m² (44.13 sq ft)
Fuselage length: 9.24 m (30.33 ft)

Height to top of rotor hub: 2.72 m (8.92 ft)
Cabin doors (2):
height: 1.13 m (3.71 ft)
width: 0.94 m (3.08 ft)



Westland Wasp of the Indonesian Navy (Westland)

Weights
Manufacturer's weight, empty: 1,566 kg (3,452 lb)
Max take-off weight: 2,950 kg (5,500 lb)
Max internal fuel: 562 kg (1,240 lb)

Performance
Max level speed at sea level: 104 kts (193 km/h)
Max economic cruising speed: 96 kts (177 km/h)
Hovering ceiling (outside ground effect): 2,682 m (8,800 ft)
Hovering ceiling (inside ground effect): 3,810 m (12,500 ft)
Max range with standard fuel: 263 n miles (488 km)
Range with max fuel, including 5 min for take-off and landing; 15 min cruising at optimum altitude; 4 passengers: 234 n miles (435 km)

Power plant: 1—710 ehp (derated) Rolls-Royce/Bristol Nimbus 503 turboshaft
Fuel: Total fuel capacity 705 litres (186 US gallons)
Accommodation: Pilot and max 4 passengers
Avionics: PTR 170 UHF radio/homer, and PV 141 standby UHF radio. Blind-flying instrumentation
Weapons: 2 Mk 44 or 1 Mk 46 torpedoes, or 2 AS.12 anti-ship missiles

FURTHER INFORMATION

PROGRAMME

The Wasp was designed to meet a late 1950s British Navy requirement for a small anti-submarine helicopter to operate from frigate-sized platforms. The basic aim was to use the ship's sensors to locate, track and identify the target — which was assumed to be a high-speed, nuclear-powered submarine — and the helicopter would then fly rapidly to the general area of the target where it would drop two homing torpedoes. The selected aircraft was the Saunders-Roe P.531, but that company was then taken over and the helicopter was developed as the Westland Wasp. Over 70 Wasps were delivered to the British Navy and approximately 40 new-build aircraft were exported, mainly to the Netherlands.

New Zealand Wasp: seven remain in service of 17 delivered and will be replaced in 1997/98 (Westland)

NAVAL OPERATORS

Indonesia: The Indonesian Navy bought 10 Wasps from the Dutch Navy, of which nine survive. They are operated from the 'Ahmad Yani' class frigates (Dutch-built versions of the British 'Leander' class).
Malaysia: Malaysia bought six former British Navy Wasps, in order to gain experience of shipborne helicopter operations. These operate from the navy's 'Rahmat', 'Hang Tuah' frigates, and the 'Kasturi' class corvettes. They will also operate from the 'Lekiu' class frigates when they join the fleet.
New Zealand: The New Zealand Navy purchased a total of 17 new-build and ex-British Navy Wasps, of which at least five are still in service. These operate from the navy's 'Leander' class frigates, and will operate from the new 'Anzac' class ships when they enter service. However, there is currently a competition for a replacement for the Wasp, which, as of early 1996, has been narrowed down to the Kaman SH-2 Seasprite and Westland Super Lynx.

WESTLAND SEA KING

AIRCRAFT

Type: Anti-submarine, search and rescue, and airborne early warning helicopter

In naval service: Australia (7); Belgium (5); Egypt (5); Germany (22); India (37); Norway (10); Pakistan (6); Qatar (8); UK (91)

SPECIFICATIONS

Dimensions
Main rotor:
diameter: 18.90 m (62.0 ft)
disc area: 280.6 m² (3,020.3 sq ft)
Tail rotor:
diameter: 3.16 m (10.37 ft)
disc area: 7.79 m² (83.86 sq ft)
Length overall (both rotors turning): 21.91 m (71.88 ft)
Fuselage length: 17.00 m (55.77 ft)
Height to rotor head: 5.10 m (16.73 ft)

Weights
Empty (equipped):
ASW: 7,331 kg (16,163 lb)
ASV: 7,625 kg (16,810 lb)
AEW: 7,417 kg (16,353 b)

Sea King HAS Mk 6 (Westland)

Westland Sea King AEW Mk 3, the latest upgraded version for the British Navy (UK MoD/HMS Heron)

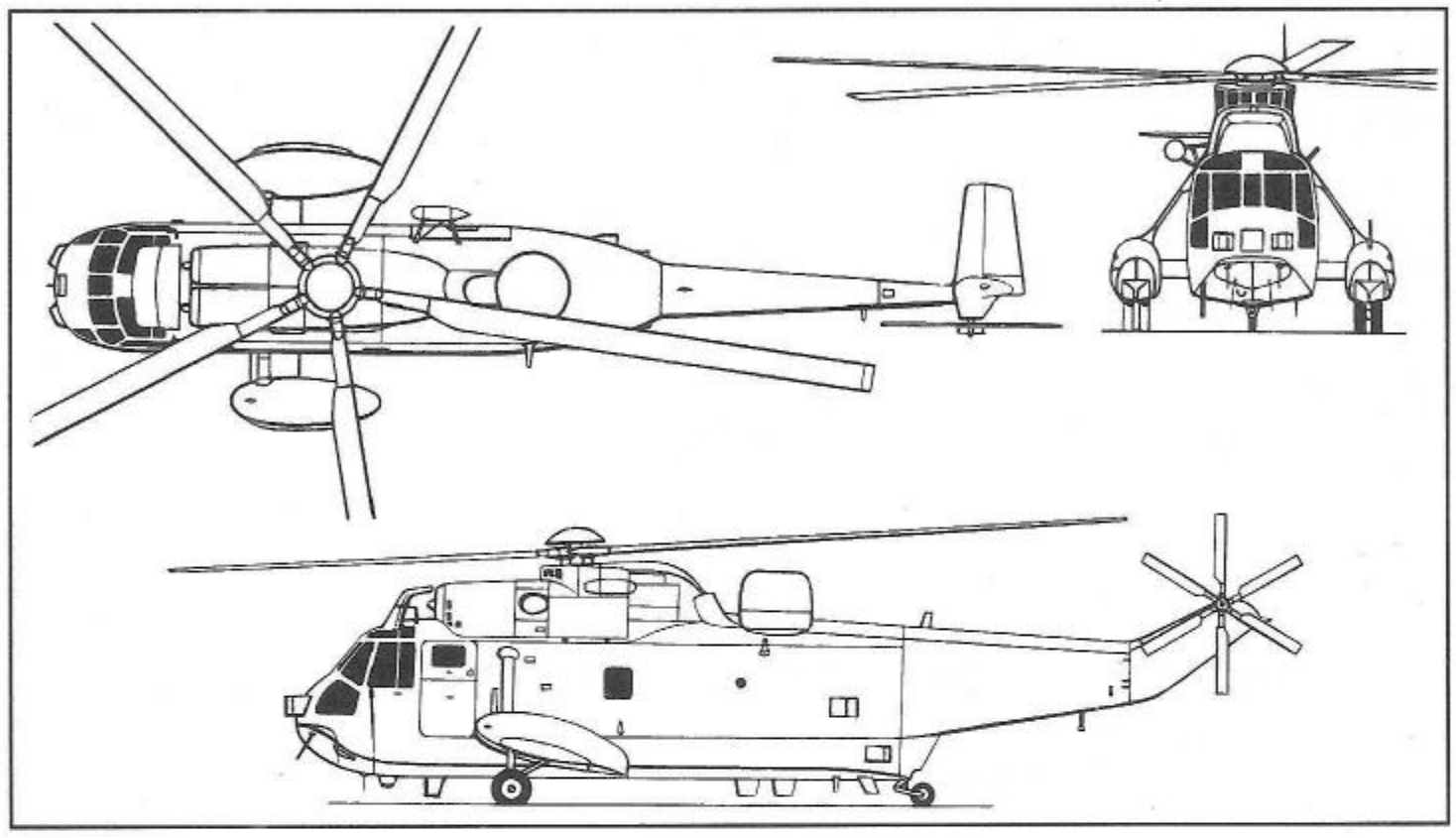
Commando: 5,620 kg (12,390 lb)
Max take-off: 9,752 kg (21,500 lb)

Performance
Never exceed speed (VNE): 122 kts (226 km/h)
Typical cruising speed: 110 kts (204 km/h)
Service ceiling: 1,220 m (4,000 ft)
Range with max standard fuel: 800 n miles (1,482 km)

Power plant: 2—1,238 kW (1,660 shp) Rolls-Royce Gnome H-1400-IT turboshafts
Fuel: Normal fuel capacity 3,714 litres (981 US gallons)
Accommodation
ASW role: 4 (pilot, co-pilot, two sonar operators)
SAR: Crew plus 22 survivors (18, if radar fitted)
Casevac: 9 stretchers; 2 attendants
Transport: 28 troops (45 overload in Commando)

Avionics (Advanced Sea King — ASW role)
Communications: Collins AN/ARC-182 UHF/VHF and homer, Ultra D 403M standby UHF, Collins 718U-5 HF radio
Dipping sonar: GEC Ferranti 2069, GEC-Plessey Type 195, Bendix/King AN/ASQ-13B or Alcatel HS-312
Navigation: GEC Avionics Doppler
Radar: MEL Super Searcher in dorsal radome
Internal MAD: CAE Electronics AN/ASQ-504(V)

Armament
ASW: Max 4 Mk 46, Whitehead A244S or Sting Ray homing torpedoes, or 4 Mk 11 depth charges
ASV: 2 Exocet (Pakistan, Qatar), 2 Sea Eagle (India)



Westland HAS. Mk 6 (Jane's/Dennis Punnett)

Westland Sea King Mk 41 search and rescue version, in service with the German Navy (Jane's/Paul Tompkins)

FURTHER INFORMATION

PROGRAMME

British company Westland made an early decision to base its helicopter manufacturing activities on Sikorsky types built under licence. Thus, it built the S-53 as the Dragonfly, the S-55 as the Whirlwind and the S-58 as the Wessex. A licence-built version of the Sikorsky SH-3 Sea King was, therefore, offered to the British Navy as a replacement for the Westland-built S-58 Wessex. This aircraft is fitted with much British equipment and numerous versions have been sold to navies around the world, although only the British and Indian navies use them in the shipboard role.

NAVAL OPERATORS

India: The Indian Navy operates a total of 32 Sea King helicopters. Of these, 27 operate in the anti-submarine, anti-ship and search-and-rescue roles: four Mk 42, three Mk 42A and 20 Mk 42B, the latter being armed with Sea Eagle ASMs and equipped with Sintra-Alcatel

Rotor and engine detail on a Westland Sea King AEW Mk 2A (Rolls-Royce)

MS-12 dipping sonars. The remaining five aircraft, all Mk 42Cs, are assault transports.

Both aircraft carrier air wings include Sea Kings. *Viraat*'s air wing has seven Sea King Mk 42B/C, while *Vikrant*'s has nine — six ASW Mk 42Bs and three Mk 42C transports. In addition, the 'Godavari' and Improved 'Godavari' class frigates both carry one Sea King as well as one Chetak (licence-built Alouette-III), while the new 'Delhi' class destroyers will each carry two ASW Sea Kings.

UK: The British Navy uses a large number of Sea Kings of which the current shipboard versions are the HAS Mk 6 anti-submarine version, AEW Mk 2A airborne early warning version and HC Mk 4 assault transport.

The air wing aboard 'Invincible' class carriers always includes up to twelve Sea Kings, usually split between nine Sea King HAS Mk 6 and three Sea King AEW Mk 2A. One Sea King HAS Mk 6 can also be deployed in some frigates: Type 22 Batch 2 (F94 to F96 and F98 only) and Type 22 Batch 3.

WESTLAND LYNX

AIRCRAFT

Role: Twin-engined multipurpose helicopter

In naval service: Brazil (7); Denmark (12); France (34); Germany (17); Netherlands (22); Nigeria (3); Norway (5); Pakistan (3); UK (80)

SPECIFICATIONS

Westland Lynx SH-14D of the Dutch Navy, armed with two Mk 46 torpedoes, is refuelled aboard a frigate (Royal Netherlands Navy)

Dimensions
Main rotor:
diameter: 12.80 m (42.00 ft)
disc area: 128.7 m² (1,385.4 sq ft)
Tail rotor:
diameter: 2.21 m (7.25 ft)
rotor disc area: 3.84 m² (41.28 sq ft)
Length overall:
rotors turning: 15.165 m (49.75 ft)
rotor blades and tail folded: 10.62 m (34.84 ft)
Width overall, main rotor blades folded: 2.94 m (9.65 ft)
Height overall:
both rotors stopped: 3.48 m (11.42 ft)
rotor blades and tail folded: 3.20 m (10.5 ft)
Wheel track: 2.78 m (9.12 ft)
Wheelbase: 2.94 m (9.65 ft)
Cabin doorway:
width: 1.37 m (4.5 ft)
height: 1.19 m (3.90 ft)

Weights
Manufacturer's weight, empty; 2,740 kg (6,040 lb)
Manufacturer's basic weight: 3,030 kg (6,680 lb)
Operating weight empty, equipped:
anti-submarine strike: 3,343 kg (7,370 lb)
reconnaissance (crew of 2): 3,277 kg (7,224 lb)
anti-submarine classification and strike: 3,472 kg (7,654 lb)
air to surface vessel search and strike (crew of 2 and 4 Sea Skuas): 3,414 kg (7,526 lb)
search and rescue (crew of 3): 3,416 kg (7,531 lb)
dunking sonar search and strike: 3,650 kg (8,047 lb)
Max take-off weight:
Gem Mk 41: 4,763 kg (10,500 lb)
Gem Mk 42: 4,876 kg (10,750 lb)

Performance (at normal max take-off weight at sea level, ISA, except where indicated)
Max continuous cruising speed:
ISA: 125 kts (232 km/h; 144 mph)
ISA +20°C: 114 kts (211 km/h; 131 mph)
Speed for max endurance (ISA/ISA + 20°C): 70 kts (130 km/h)
Max forward rate of climb:
ISA: 661 m (2,170 ft)/min
ISA + 20°C: 469 m (1,540 ft)/min
Max vertical rate of climb:
ISA: 351 m (1,150 ft)/min
ISA +20°C: 244 m (800 ft)/min
Hovering ceiling out of ground effect: 2,575 m (8,450 ft)
Radius of action, search and rescue mission, out and back, at max sustained speed, with allowances for take-off and landing, 30 min loiter in search area, 3 min hover for each survivor, 10% fuel reserves at end of mission, crew of 3:
2 survivors: 115 n miles (212 km)
7 survivors: 96 n miles (178 km)
Time on station, anti-submarine mission, at 50 n miles (93 km) radius, out and back at max sustained speed, with 2 torpedoes, smoke floats and marine markers, allowances for take-off and landing and 10% fuel reserves at end of mission:
classification and strike, loiter speed on station: 2 h
strike, loiter on station: 2 h 29 min
dunking sonar search and strike, 50% loiter speed and 50% hover on station: 1 h 5 min
Time on station, anti-surface vessel strike, at 50 n miles (93 km) radius, out and back at max sustained

speed, with crew of 2 and 4 Sea Skuas, allowances and reserves as above:

en route radar search and loiter speed on station: 1 h 36 min

Max range: 320 n miles (593 km)

Max endurance (ISA +20°C): 2 h 50 min

Max ferry range with auxiliary cabin tanks: 565 n miles (1,046 km)

Power plant: 2 Rolls-Royce Gem 2 turboshafts, each with max contingency rating of 671 kW (900 shp) in Lynx HAS.2 and early export variants. Later versions have Gem 41-1, 41-2, or 42-1 engines, all with max contingency rating of 835 kW (1,120 shp). Transmission rating 1,372 kW (1,840 shp). Engines of British and French Lynx in service converted to Mk 42 standard during regular overhauls from 1987 onwards. Danish, Netherlands and Norwegian Lynx similarly retrofitted

Fuel: Fuel in 5 internal tanks; usable capacity 957 litres (253 US gallons) when gravity-refuelled; 985 litres (260 US gallons) when pressure-refuelled. For ferrying, 2 tanks each of 441 litres (116 US gallons) in cabin, replacing bench tank. Max usable fuel 1,867 litres (493 US gallons)

Accommodation: Pilot and co-pilot/observer on side by side seats, with optional dual controls. Seats can be removed quickly to permit carriage of up to 907 kg (2,000 lb) of freight internally. In casualty evacuation role, with a crew of 2, Lynx can accommodate up to 6 Alphin stretchers and a medical attendant. Also capable of search and rescue (up to 9 survivors) and other roles

Weapons

General: ASW armament incl 2 Mk 44, Mk 46, A244S or Sting Ray homing torpedoes, 1 each on an external pylon on each side of fuselage, and 6 marine markers; or 2 Mk 11 depth charges. Alternatively, up to 4 Sea Skua semi-active homing missiles

Westland Lynx HMA Mk 8(Jane's/Paul Tompkins)

French Navy: 4 AS.12 or similar wire-guided missiles.

British Navy: self-protection FN HMP 0.50 in machine gun pod optional

Avionics

Communications: General — Collins VOR/ILS; DME; Collins AN/ARN-118 Tacan; I-band transponder; GEC-Plessey PTR 446, Collins APX-72, Siemens STR 700/375 or Italtel APX-77 IFF; British Navy — two GEC-Marconi AD 3400 VHF/UHF transceivers, Dowty D403M standby UHF radio, Collins 718U-5 HF transceiver, Plessey PTR446 D-band transponder and Pilkington ARI 5983 I-band transponder

Radar: British Navy — GEC-Marconi ARI5979 Seaspray Mk 1 lightweight search and tracking radar

Flight: General — GEC-Marconi duplex 3-axis automatic stabilisation equipment; BAe GM9 Gyrosyn compass system; Decca tactical air navigation system (TANS); Decca 71 Doppler, E2C standby compass. GEC-Marconi Mk 34 AFCS. When sonar is installed, additional units are fitted to provide automatic transition to hover and automatic Doppler hold in hover. British Navy Lynx will have GPS from 1997

Mission

General — ASW versions have dipping sonar and/or MAD; British Navy — Racal MIR-2 Orange Crop passive radar detection system; CAE Electronics AN/ASQ-504(V) internal MAD, optional GEC Sandpiper FLIR; Danish Navy — Racal Kestrel passive radar detection system retrofitted, FLIR Systems Safire optional; French Navy — Matra AF 530 or APX-334 stabilised sight; Netherlands Navy — FLIR Systems 2000HP in SH-14D upgrade

Self-Defence

British Navy — Tracor M-130 chaff/flare dispensers and Ericsson Radar Electronics AN/ALQ-167(V) D- to J-band anti-ship missile jamming pods installed on RN Lynx patrolling Arabian Gulf, 1987. 2 Loral Challenger IR jammers above cockpit of RN Lynx during 1991 Gulf War

FURTHER INFORMATION

PROGRAMME

The Lynx was developed within the Anglo-French helicopter agreement, which was signed on 2 April 1968. While the French were given design leadership in the Puma and Gazelle, Westland was given the leadership in the Lynx project. The first prototypes flew on 21 March 1971 and the first production naval aircraft, a British Navy HAS. Mk 2 on 20 February 1976, with production being shared between Westland and Aerospatiale on a 70:30 basis.

Since that time the basic Lynx has been progressively developed and has sold widely, with a total of 357 of all types ordered by 13 customers, of which 211 helicopters have been naval versions and nine of the customers have been navies. The Lynx carries out duties ranging from anti-submarine classification and strike, through air-to-surface vessel search and strike, SAR, reconnaissance, troop transport and fire support to communications, liaison within the fleet liaison, and vertrep (vertical replenishment).

NAVAL OPERATORS

Note: HAS = Helicopter Anti-Submarine; HMA = Helicopter Maritime Attack

Brazil: Brazil purchased nine HAS. Mk 21 (SAH-11 in Brazilian service), which were given the additional role of anti-surface ship strike in 1988. They operate from the 'Niteroi', 'Inhauma', 'Greenhalgh' and 'Para' class frigates. Seven remain, of which five have been upgraded since 1993, raising them to Super Lynx standard with Sea Spray Mk 3 radar and Racal Kestrel EW suite; they also have Racal MIR 2 ESM. For the ASW role they are armed with two Mk 44 or Mk 46 torpedoes, or depth bombs, while for anti-ship strikes they carry four BAe Sea Skua missiles.

Denmark: The Danish Navy operates 12 Lynx, of which 11 were bought from Westland (eight Mk 80s and two embargoed Mk 23s from the Argentine order) and one new Mk 90. In addition, one Mk 23 was purchased from Argentina. All have been upgraded to Mk 91 standard and operate aboard the 'Thetis' and 'Beskyttern' class frigates. They are unarmed, being mainly used for EEZ patrol and SAR.

France: 40 Lynx were delivered as part of the Anglo-French helicopter programme, of which 34 now remain. Originally there were two types — HAS Mk 2(FN) and HAS Mk 4(FN), but all are now Mk 4 standard. They are fitted with French sensors, including OMERA-Segid ORB-31W search radar, Alcatel DUAV 4 dipping sonar and sonobuoys. ASW weapons are two Mk 46 Mod 1 (or Mu 90 in due course) torpedoes, or depth charges, or four AS12 missiles in the ASV role. They operate from 'Georges Leygues', 'Cassard' and 'Tourville' class frigates.

Germany: The German Navy operates 17 Mk 88 Lynx from the 'Bremen' and 'Brandenburg' class frigates, their roles being ASW and ASV in support of coastal defence units and ASW in the North and Baltic Seas. They are currently equipped with Ferranti Sea Spray Mk 1 radar, ECM and Bendix AQS-18 dipping sonar, and can carry one or two Mk 46 torpedoes or depth charges. These aircraft are to be upgraded as part of a 1995 contract and may also be supplemented by a further order of new aircraft.

Netherlands: The Dutch Navy purchased 24 Lynx: six Mk 25 utility (designated UH-14A in Dutch service); 10 Mk 27 (SH-14B) with sonar; and eight Mk 81 (SH-14C) with MAD. The SH-14Cs were subsequently converted to SH-14B standard, but now the 22 survivors of all types are being converted/upgraded to common SH-14D ASW standard. Sensors include Ferranti Sea Spray radar, Alcatel DUAV-4 dipping sonar, FLIR Model 2000 and Ferranti AWARE-3 ESM. Weapons carried are either two Mk 46 torpedoes or depth bombs. These aircraft operate from 'Tromp' class destroyers, and 'Kortenaer' and 'Karel Doorman' class frigates.

Nigeria: Nigeria purchased three Mk 89s, of which two remain, for operations from the single 'Aradu' class (Meko 360) frigate. They are fitted with the RCA 5000 radar and carry two Whitehead 244/S torpedoes. They

German Navy Westland Lynx Mk 88 (Jane's/Paul Tompkins)

Westland Lynx Mk 4 (FN) of the French Navy (Jane's/Peter Felstead)

Westland Lynx AH Mk 7 of the British 847 Naval Air Squadron, which provides support for 3 Commando Brigade of the Royal Marines (UK MoD/HMS *Heron*)

can also carry one 7.62 mm machine gun on a flexible mount in the cabin doorway. Like the Nigerian naval ships, their serviceability is extremely doubtful.

Norway: Norway bought six Mk 86s of which five remain. They are operated by the air force on behalf of the Coastguard and are regularly embarked in the Coastguard's 'Nordkapp' class patrol vessels. Lynx' roles include fishery protection, offshore oil protection and SAR, for all of which they are usually unarmed.

Pakistan: The Pakistan Navy purchased three Lynx HAS. 3, which were delivered in 1994 (two) and 1995 (one), and has an option on three more. They have Ferranti Sea Spray radar and Orange Crop ESM, and can be armed with either two Whitehead Type 244/S torpedoes, four BAe Sea Skua missiles, or two 12.7 mm MG pods.

United Kingdom: The current fleet comprises some 80 Westland Lynx HMA Mk 3/8. A total of 60 HAS Mk 2 was purchased, of which 53 were subsequently upgraded to HAS Mk 3 standard, joining 31 new-build. 65 of the Mk 3 fleet are now being upgraded to HMA Mk 8 standard. All versions are fitted with Ferranti Sea Spray radar, 'Orange Crop' ESM, chaff and flare dispenser. In the ASW role two Sting Ray torpedoes or Mk 11 depth bombs are carried, while in the anti-surface vessel role four Sea Skua missiles are carried. In addition, two 12.7 mm MG pods can be fitted. The current updating programme includes fitting Sea Owl passive identification and centralised tactical system and MAD. Special modifications such as additional cooling and flotation bags are incorporated into Lynx destined to fly in the Persian Gulf (their designation carries the suffix 'GM' (Gulf-modified).

Two other versions are operated by the navy. In 1995 the navy also took over responsibility for operating six Royal Marine Lynx AH Mk 1s, which are intended for anti-armour (up to 8 Hughes TOW anti-tank missiles can be carried) or personnel/stores movement. The other version is the HAS. Mk 3ICE, an austere version designed for use as a utility helicopter aboard the Antarctic support ship, HMS *Endurance;* two were converted. Actual RN Lynx status in January 1995 was: nine Mk 3, three Mk 3GM, 36 Mk 3S, seven Mk 3CTS, 14 Mk 3S/GM, two Mk 3ICE and seven Mk 8.

DESIGN

The compact design was selected as especially suitable for autonomous hunter-killer ASW and missile-armed anti-ship naval roles from ships down to frigate size. The single, four-bladed, semi-rigid, main rotor is foldable and on naval Lynx the tail pylon can also be folded (manually). In addition to the weapon stations for torpedoes and anti-ship missiles, there is provision for internally mounted armament, and for an exterior universal flange mounting on each side for other weapons/stores. Maximum vertical descent 2.29 m (7.5 ft) per second, with lateral drift of 0.91 m (3 ft) per second for deck landing. Flotation gear, and hydraulically actuated harpoon deck lock securing system are both optional.

WESTLAND HMA MK 8/SUPER LYNX

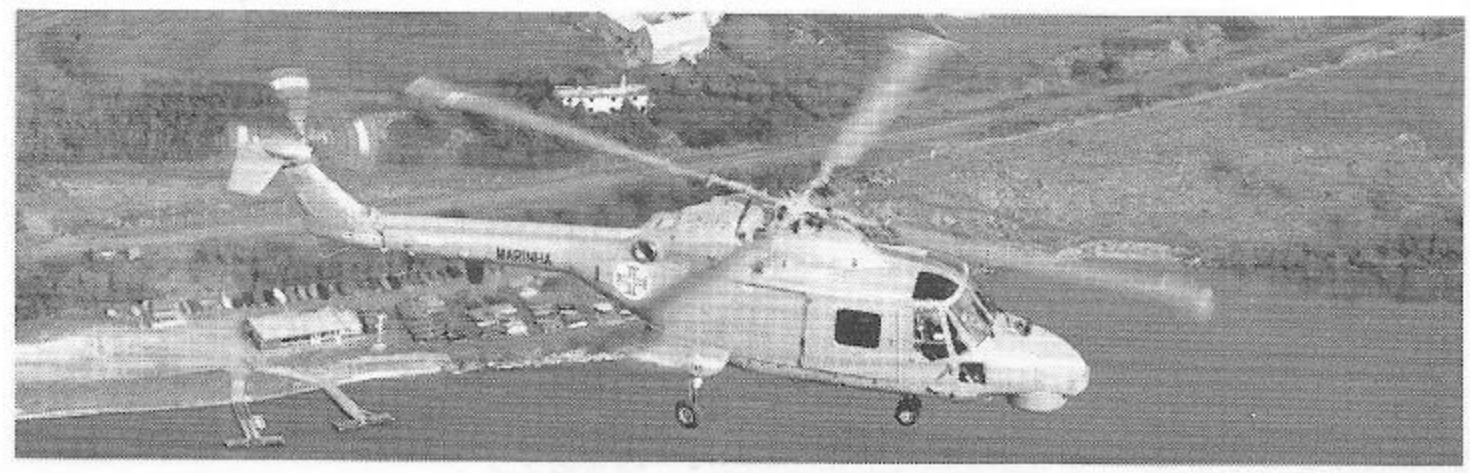
AIRCRAFT

Type: Twin-engined multipurpose naval helicopters

In naval service: Brazil (15); South Korea (12); Portugal (5); UK (45)

SPECIFICATIONS

Dimensions
Main rotor:
diameter: 12.80 m (42.0 ft)
disc area: 128.71 m² (1,385.44 sq ft)
Tail rotor:
diameter: 2.36 m (7.75 ft)
disc area: 4.38 m² (47.17 sq ft)



Super Lynx Mk 95 of the Portuguese Navy (Westland)

The 'BERP' (British Experimental Rotor Programme) blade has anhedral, swept, high-speed tips of increased chord (Westland)

British Navy Westland Lynx HMA Mk 8, armed with Sea Skua anti-ship missiles. The Ferranti Sea Spray radar is in the undernose bin, enabling the GEC-Marconi Sea Owl thermal imager to be placed on a gimballed mount in the position occupied by the radar in earlier marks (Westland)

Length overall:
rotors turning: 15.24 m (50.0 ft)
rotor blades and tail folded: 10.85 m (35.60 ft)
Width overall, main rotor blades folded: 2.94 m (9.65 ft)
Height overall:
rotors turning: 3.67 m (12 ft 0½ in)
rotor blades and tail folded: 3.25 m (10.66 ft)
Wheel track: 2.80 m (9.19 ft)
Wheelbase: 3.02 m (9.91 ft)

Weights
Basic weight empty: 3,291 kg (7,255 lb)
Operating weight empty (incl crew and appropriate armament):
ASW (2 torpedoes): 4,618 kg (10,181 lb)
ASV (4 Sea Skuas): 4,373 kg (9,641 lb)
surveillance and targeting: 3,708 kg (8,174 lb)
search and rescue: 3,778 kg (8,329 lb)
Max underslung load: 1,361 kg (3,000 lb)
Max take-off weight: 5,125 kg (11,300 lb)
Max disc loading: 39.82 kg/m² (8.16 lb/sq ft)
Max power loading: 3.74 kg/kW (6.14 lb/shp)

Performance
Never exceed speed (VNE), Mk 9 (clean): 156 kts (289 km/h)
IR exhaust diffusers fitted: 145 kts (269 km/h)
Radius of action:
anti-submarine, 2 h on station, dipping sonar and 1 torpedo: 20 n miles (37 km)
point attack with 4 Sea Skuas: 125 n miles (232 km)
surveillance, 3 h 50 min on station: 75 n miles (139 km)

Power plant: 2 Rolls-Royce Gem 42-1 turboshafts, each rated at 835 kW (1,120 shp). Transmission rating 1,372 kW (1,840 shp)

Avionics
Radar: Nose radar has been repackaged and placed in a bin under the nose to leave space for the GEC-Marconi Sea Owl thermal imaging equipment above nose. British HMA Mk 8 Lynx was to have had Sea Spray Mk 1 upgraded to Mk 3 but this has been cancelled and the Mk 1 retained. Export Super Lynx has Mk 3 or Bendix/King RDR 1500 360° scan radar in the new chin radome

Mission
Vinten Vipa 1 reconnaissance pod; or Agiflite reconnaissance camera system. Optional Bendix/King AN/AQS-18 or Thomson Sintra HS-312 sonars

Armament
ASW armament includes 2 Mk 44, Mk 46, A244S or Sting Ray homing torpedoes, 1 each on an external pylon on each side of fuselage, and 6 marine markers; or 2 Mk 11 depth charges. Alternatively, up to 4 Sea Skua or 2 Penguin anti-ship missiles

FURTHER INFORMATION

PROGRAMME

The great majority of the British Navy's Lynx are being upgraded to HMA Mk 8 standard, which is virtually identical to that of the Super Lynx being built for export. Brazilian, Dutch, French and German Lynx are also being upgraded to virtually the same standard.

Lynx HMA Mk 8

The British Navy is standardising its fleet on the Lynx HMA. Mk 8, which is equivalent in most respects to the export Super Lynx (see below). In this new version, the engines are replaced by Rolls-Royce Gem 42 Srs 200, each rated at 686 kW (920 shp), enabling maximum take-off weight to be increased first to 5,125 kg (11,300 lb) and later to 5,334 kg (11,760 lb). The direction of rotation of the tail rotor has been reversed to improve control, particularly in yaw. The main rotor blades are replaced by a new design of blade known as BERP (British Experimental Rotor Programme), which has anhedral, swept, high-speed tips of increased chord, and is constructed of composite materials. This unique type of blade results in much improved speed and lift, as well as giving a much greater fatigue life.

Another major enhancement is the Racal RAMS 4000 central tactical system (CTS), which eases crew workload by processing sensor data centrally and presents mission information on a multifunction CRT display. Plans to replace the Sea Spray Mk 1 by the Mk 3 have been cancelled for economic reasons, but the radar has been moved to a new chin radome, enabling a GEC-Marconi Sea Owl thermal imager (×5 or ×30 magnification) to be placed on a gimballed mount (elevation +20 to −30°; azimuth ±120°) which occupies the position formerly used by the radar. The MIR-2 'Orange Crop' ESM suite has also been updated, a Whittaker 'Yellow Veil' ECM jamming pod fitted, and the navigation system uprated by installing Racal RNS252 'Super TANS' with its associated TNL8000 GPS. A planned internal MAD has not, however, been adopted, for economic reasons. The 12.7 mm MG pod which can be fitted on the HMA Mk 3 is not used on the HMA Mk 8.

Super Lynx

The Super Lynx is an upgraded export Lynx, which has much in common with the HMA Mk 8 used by the British Navy, including a maximum take-off weight of 5,125 kg (11,300 lb), all-weather day/night capability and extended payload/range. The swept-tip (BERP) composite main rotor blades offer improved speed and aerodynamic efficiency, together with reduced vibration, while the reversed direction tail rotor gives improved control.

Although the Sea Owl thermal imager is offered as an option, no export customer has yet taken this up, and thus, while all Super Lynx have their Sea Spray Mk 3 radar in an undernose bin, the top of the nose has a smoothly curved profile.

Mk 95 Super Lynx of the Portuguese Navy (Westland)

NAVAL OPERATORS

Brazil: Six of Brazil's Mk 21 Lynx are being upgraded by Westland to Super Lynx standard and nine new-build Super Lynx have been ordered (designated Mk 21A) for delivery from 1996. Mk 21A avionics include 360° Sea Spray 3000 radar, RNS252 INS and Doppler 71. Armament fit will include provision for Sea Skua missiles.
South Korea: 12 Super Lynx Mk 99 were ordered by South Korea in 1988 for deployment aboard its 'Sumner' and 'Gearing' class destroyers. These aircraft are fitted with Racal Avionics Doppler 71/TANS N navigation system, Sea Spray Mk 3 360° radar, AN/AQS-18 dipping sonar and Sea Skua missiles.

They were delivered between July 1990 and May 1991.

Portugal: Portugal ordered five Super Lynx Mk 95 in 1990, with an option on a further three, for deployment aboard the 'Vasco da Gama' class (MEKO 200) frigates. These have Racal RNS252 GPS-aided INS and Doppler 91 navigation systems, together with some US equipment including AN/AQS-18 sonar and Bendix/King RDR 1500 radar. The first two were ex-Royal Navy modified airframes and were handed over in July 1993, while the remaining three were new-builds, delivered in November 1993.

United Kingdom: These aircraft will operate aboard Type 42 destroyers, Type 22 and 23 frigates, and some RFAs (Royal Fleet Auxiliaries). 45 of the current Mk 3, Mk 3S and Mk 3CTS will be converted to the new Mk 8 standard, with the work being completed by 2001, enabling the aircraft to remain in service until about 2012.

One of 17 Super Lynx for the South Korean Navy (Westland)

BELL/BOEING V-22 OSPREY

AIRCRAFT

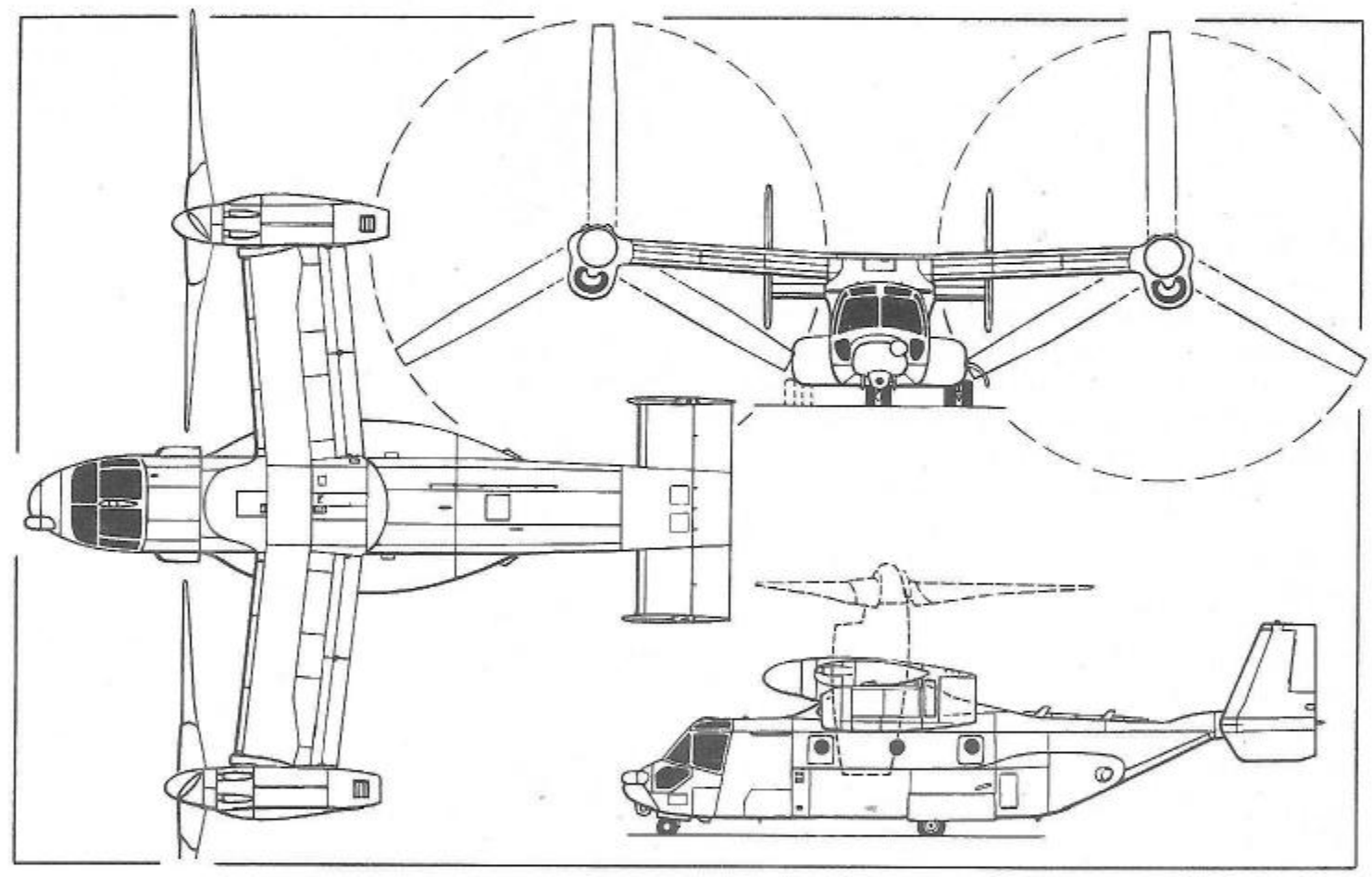
Type: Twin-engined, tilt-rotor, multimission aircraft

SPECIFICATIONS

Dimensions
Rotors:
diameter, each: 11.58 m (38.0 ft)
area, each: 105.4 m² (1,134 sq ft)
Wing span:
excl nacelles: 14.02 m (46 ft 0 in)
incl nacelles: 15.52 m (50.92 ft)
Width:
rotors turning: 25.55 m (83.83 ft)
stowed: 5.61 m (18.41 ft)
Length:
fuselage, excl probe: 17.47 m (57.32 ft)
overall, wings stowed/blades folded: 19.09 m (62.63 ft)
Height:
over tailfins: 5.38 m (17.65 ft)
wings stowed/blades folded: 5.51 m (18.08 ft)
overall, nacelles vertical: 6.63 m (21.75 ft)
Tail span, over fins: 5.61 m (18.41 ft)
Wheel track (c/l of outer mainwheels): 4.62 m (15.16 ft)
Wheelbase: 6.59 m (21.62 ft)

Weights
Weight empty: 15,032 kg (33,140 lb)
Max fuel weight:
standard: 6,215 kg (13,700 lb)
with self-ferry cabin tanks: 13,641 kg (30,074 lb)
Max internal payload (cargo): 9,072 kg (20,000 lb)
Cargo hook capacity:
single: 4,536 kg (10,000 lb)
2 hooks (combined weight): 6,804 kg (15,000 lb)
Rescue hoist capacity: 272 kg (600 lb)
Normal mission take-off weight:
VTO: 21,545 kg (47,500 lb)
STO: 24,947 kg (55,000 lb)
Max STO weight for self-ferry: 27,442 kg (60,500 lb)

Performance
Max cruising speed:
helicopter mode (sea level): 100 kts (185 km/h)
aeroplane mode (sea level): 275 kts (509 km/h)
aeroplane mode (optimum altitude): 314 kts (582 km/h)
Max forward speed with max slung load: 130 kts (241 km/h)
Max vertical rate of climb (sea level): 332 m (1,090 ft)/min
Max inclined rate of climb (sea level): 707 m (2,320 ft)/min
Service ceiling: 7,925 m (26,000 ft)
Hovering ceiling (out of ground effect): 4,331 m (14,200 ft)

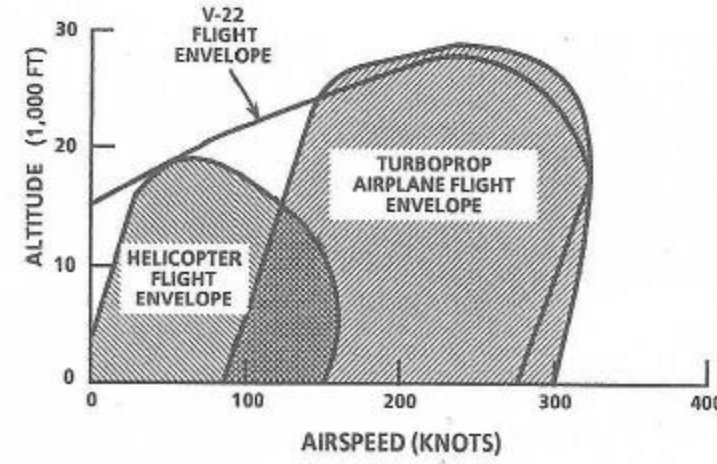


Bell/Boeing V-22 Osprey

Take-off run at normal mission STO weight: less than 152 m (500 ft)
Range:
amphibious assault: 515 n miles (935 km)
VTO at 21,146 kg (46,619 lb) gross weight, incl 5,443 kg (12,000 lb) payload: 1,200 n miles (2,224 km)
STO at 24,947 kg (55,000 lb) gross weight, incl 9,072 kg (20,000 lb) payload: 1,800 n miles (3,336 km)
STO at 27,442 kg (60,500 lb) self-ferry gross weight, no payload: 2,100 n miles (3,892 km)

Power plant: 2 Allison T406-AD-400 (501-M80C) turboshafts, each with take-off and intermediate rating of 4,586 kW (6,150 shp) and max continuous rating of 4,392 kW (5,890 shp). Each engine is installed in a Bell-built tilting nacelle at the wingtip, driving a 3-blade 11.58 m (38.0 ft) proprotor

Fuel (JP-5)
Internal: 2—1,115 litres (295 US gallon) forward cells, 1 in each sponson; 1—2,417 litres (638.5 US gallon) cell in rear of starboard sponson; 8—319 litres (84.2 US gallon) auxiliary cells, 4 in each wing leading-edge; 2—428 litres (113 US gallon) engine feed cells outboard of the auxiliary tanks in each wing; Total — 7,627 litres (2,015 US gallons) in 13 crash-resistant, self-sealing cells
Additional: 4 additional auxiliary fuel tanks, each 2,305 litres (609 US gallons) in main cabin for self-deployment mission; Total — 9,221 litres (2,436 US gallons)



A comparison of the flight envelopes of a typical helicopter, a typical turboprop aircraft and the V-22 (Bell Helicopter Textron)

Accommodation (MV-22A)
Crew: Pilot (starboard seat), co-pilot and crew chief in Simula crashworthy armoured seats capable of withstanding strikes from 0.30 in armour-piercing ammunition, 30 *g* forward and 14.5 *g* vertical decelerations
Main cabin: Accommodates up to 24 combat-equipped troops, on inward-facing crashworthy fold-away seats, plus 2 gunners; up to 12 litters plus medical attendants; or an equivalent cargo load with energy absorbing tiedowns. Cargo handling provisions incl a 907 kg (2,000 lb) capacity cargo winch and pulley system and removable roller rails

Avionics
Radio: VHF/AM-FM, HF/SSB; IFF
Radar: (USN only) Texas Instruments AN/APQ-174 terrain-following multifunction radar in offset (to port) nose thimble
Flight: Tacan, VOR/ILS, AHRS, radar altimeter and digital map displays; Jet Inc ADI-350W standby attitude indicator; Aydin Vector data acquisition and storage system. 2 Control Data AN/AYK-14 mission computers, with Boeing/IBM software
Instrumentation: Pilots' night vision system and Honeywell integrated helmet display system. Radar-equipped aircraft have two Bendix/King IP-1555 full colour multifunction displays

Mission
Variant of Hughes Aircraft AN/AAQ-16 FLIR in under-nose fairing

Self-Defence
Honeywell AN/AAR-47 missile warning system; radar/infra-red warning system; chaff/flare dispensers

Armament
Provision stipulated in December 1994 for nose cannon

FURTHER INFORMATION

PROGRAMME

The V-22 programme is of considerable significance to the US armed forces and especially to the US Marine Corps, which is in urgent need of a replacement for its antiquated CH46s in the shipborne assault role. Despite this urgency, the development of the V-22 has been both protracted and costly, starting as long ago as 1982, with a design based on the experimental Bell/NASA XV-15 tilt-rotor. The V-22 project began its existence as the Department of Defense Joint Services Advanced Vertical Lift Aircraft (JVX), with the programme being run by the US Army, but the programme was transferred to US Navy leadership in January 1983.

Full-scale development (FSD), which was planned to last seven years, began on 2 May 1986 with an order for six prototypes, the first of which flew on 19 March 1989. The original schedule called for delivery to the US Marines to start in late 1991/early 1992, followed by the air force in 1993 and the navy in 1995, but following problems with the programme, production funding was cut in FY90, although the development contract was maintained.

The V-22 passed a critical design review 13 December 1994 with minor provisions, including the addition of a forebody strake to eliminate buffeting and provision for a nose-mounted gun. A concurrent defence review authorised V-22 production for both marines and special forces, but the final production decision, due in December 1993, was postponed to November 1994 for new assessment of post-Cold War requirements for assault transports.

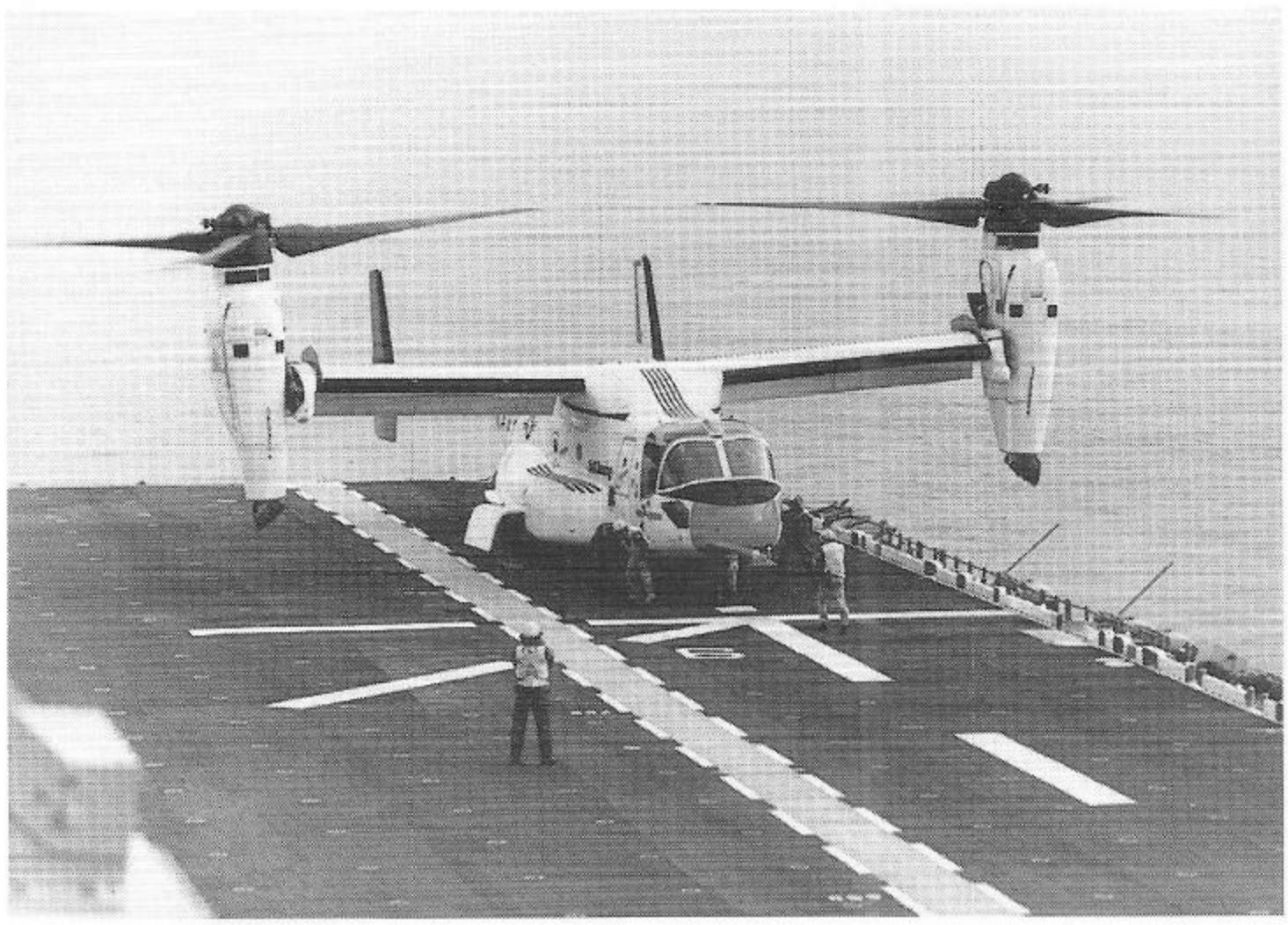
As of early 1996, the production position is that 523 aircraft will be built: 425 for the US Marine Corps, and 48 for Special Operations Forces (SOF). In addition, 50 are planned (but not yet authorised) for strike rescue by the US Navy.

Costs of the MV-22A are not cheap, production of the Marine Corps' 425 aircraft being currently estimated at: FY96 — $50 million; FY97 — $700 million; FY98 - $800 million; and FY99 $1,000 million. Unit cost was estimated at $33.4 million (at December 1994 prices), but it is hoped that this will reduce to $29 million (1993) over a production run of 612.

US marines deplane over the ramp of the V-22 (Bell Helicopter Textron)

NAVAL VARIANTS

MV-22A: This is the basic US Marine Corps assault transport, with a three-man crew and the ability to carry 24 combat-equipped troops or cargo at 250 knots (463 km/h; 288 mph) over a radius of 200 n miles (370 km). In addition, midway through such a mission, the aircraft must be able to hover at a height of 915 m (3,000 ft) out of ground effect. The original US Marine Corps requirement for 552 aircraft has been reduced to 425, and the type is scheduled to replace both the CH-46 Sea Knight and CH-53 Sea Stallion, thus serving on all types of US Navy amphibious warfare vessels. First production MV-22A will be delivered to the Marines in 1999 and IOC is scheduled for 2001.
HV-22A: A combat search and rescue (CSAR) aircraft for the US Navy, with additional tasks of special warfare and fleet logistics support. The requirement is for 48 (originally 50) and current IOC is 2006.
SV-22A: A tentative US Navy requirement exists for some 300 of an ASW version to replace S-3 Viking. A novel element of the requirement is that the SV-22A should be able to set down large ASW sensors in the open ocean, operate them from high altitude and then recover them. This would involve the SV-22A in operations aboard all attack carriers (CVN and CV).
CV-22A: The US Army has a requirement for the V-22 in medevac, special operations and combat assault support roles, while the air force requires 50 of the type as a long-range special missions aircraft. Deliveries and IOC will follow those of the US Marine Corps.
JMSDF: The only firm foreign interest to date has come from the Japan Maritime Self-Defense Force, which has a provisional commitment to fund four SAR Ospreys.



V-22 Osprey (Bell Helicopter Textron)

DESIGN

The unique feature of the V-22 is that it can take-off, hover and land like a conventional helicopter, but, by tilting its rotor system, it can also fly with the speed and comfort of an aircraft. To achieve this, the engines, transmission and proprotors tilt through 97° 30′ between forward flight and steepest approach gradient or tail-down hover, with a cross-shaft connection to keep both proprotors turning in the event of engine loss. The three-bladed, graphite/fibreglass, contrarotating proprotors have special high-twist, tapered blades

V-22 in helicopter mode (Bell Helicopter Textron)

with elastomeric bearings and powered folding mechanisms; separate swashplates produce respectively yaw and fore-and-aft translation in hover and sideways flight in level attitude. The proprotors rotate at 333 rpm, with a tip speed 201.75 m (662 ft)/s.

The wing-fold sequence required for shipboard operations starts with the engines vertical. The blades are then power-folded until they lie parallel to the wing leading-edge, whereupon the engine nacelles are tilted down to the horizontal. The entire wing/engine/proprotor groups are then rotated clockwise on a stainless steel carousel to lie over fuselage.

A V-22 halfway through its complex unfolding drill (Bell Helicopter Textron)

The aircraft features three-lane fly-by-wire with automatic stabilisation, full autopilot and formation-flying modes. Automatic control of configuration change during transition and of transfer of control from aerodynamic surfaces to rotor-blade pitch changing; flaperons and ailerons droop during hover to reduce negative lift of wing. The rotors have separate cyclic control swashplates for sideways flight and fore-and-aft control (symmetrical for forward and rearward flight and differential for yaw) in hover. Lateral attitude controlled in the hover is by differential rotor thrust, but lateral swashplate allows sideways flight in level attitude controlled by button on control column. Integrated electronic cockpit with six electronic display screens; helicopter-style control columns rather than aileron wheels, but left-handed power levers move forward for full power in opposite sense to helicopter collective lever.

STRUCTURE

Approximately 59 per cent of the airframe is made of composites, principally Hercules IM-6 graphite/epoxy in wing and AS4 in fuselage and tail, while the nacelle cowlings and pylon supports are of GFRP. Fuselage mainly 'black aluminium' consisting of conventional stringers, frames and preformed skin, all in composites, assembled with metal fasteners. Main cabin has composites floor panels and titanium window frames. Crew seats of boron carbide/polyethylene laminate. Wing box is high-strength, very stiff torsion box made up from one-piece upper and lower skins with moulded ribs and bonded stringers; two-segment graphite single-slotted flaperons with titanium fittings; three-segment detachable leading-edge of aluminium alloy with Nomex honeycomb core. Bell is responsible for the tail unit, wing, nacelles, proprotor and transmission systems and integration of the engines, while Boeing is responsible for the fuselage, landing gear and fairings and avionics integration.

BELL MODEL 206 JETRANGER

AIRCRAFT

Role: Shipborne liaison helicopter

In naval service: Brazil (19); Chile (7), Ecuador (4)

SPECIFICATIONS

Dimensions
Main rotor:
diameter: 10.16 m (33.3 ft)
disc area: 81.07 m² (872.65 sq ft)
Tail rotor:
diameter: 1.65 m (5.41 ft)
disc area: 2.14 m² (23.04 sq ft)
Fuselage length (rotors turning): 11.82 m (38.78 ft)
Fuselage: 9.50 m (31.17 ft)
Height: 2.91 m (9.55 ft)
Skid track: 1.92 m (6.30 ft)

Weights
Empty: 742 kg (1,635 lb)
Max take-off weight: 1,451 kg (3,200 lb)

Performance
Never exceed speed (VNE) at sea level: 122 kts (140 km/h)
Service ceiling: 4,115 m (13,500 ft)
Max cruising speed at 1,500 m (5,000 ft): 116 kts (134 km/h)
Range: 404 n miles (748 km)

Max rate of climb at sea level: 384 m (1,260 ft)/min
Hovering ceiling:
in ground effect: 3,900 m (12,800 ft)
out of ground effect: 2,680 m (8,800 ft)

Power plant: 1 Allison 250-C20J flat-rated at 236 kW (317 shp)
Crew: 2 (pilot, co-pilot)
Sensors: None
Typical weapons loads: Some navies fit a single torpedo or rocket pods

FURTHER INFORMATION

PROGRAMME

The Bell Model 206A JetRanger first flew in January 1966 and was soon in production, both in the USA and in Italy (Agusta-Bell AB-206). This was followed by the JetRanger II with an uprated Allison 250-C20 (298 kW (400 shp)) engine and then the JetRanger III, with an even more powerful engine.

NAVAL OPERATORS

Brazil: The Brazilian Navy operates 19 UH-6Bs (JetRanger IIIs), of which most are used as utility and training helicopters. The type is, however, also used as the shipboard helicopter aboard the 'Mariz E Barros' and 'Sergipe' class destroyers. Two machine guns or two rocket pods can be fitted.
Chile: The Chilean Navy operates seven JetRangers, which have an ASW role in war, for which they would carry one Mk 44 torpedo or a depth bomb. They operate aboard the 'Prat' class destroyers *Prat* and *Latorre*, and the 'Condell' class frigates.
Ecuador: The JetRanger is the sole shipboard helicopter operated by the Ecuador Navy and is to be found aboard the *President Eloy Alfaro* ('Leander') class frigates and 'Esmeraldas' class corvettes. They are not armed.

Chilean Navy Bell JetRanger (Chilean Navy)

Bell UH-6B JetRanger of the Brazilian Navy (Mario RV Carneiro)

BELL MODEL 209 AH-1W SUPERCOBRA

AIRCRAFT

Type: Two-seat, twin-engined close support and attack helicopter

In naval service: Taiwan (17); USA (154)

SPECIFICATIONS

Dimensions
Main rotor:
diameter: 14.63 m (48.0 ft)
disc area: 168.11 m² (1,809.56 sq ft)

Tail rotor:
diameter: 2.97 m (9.75 ft)
disc area: 6.94 m² (74.70 sq ft)
Wing span: 3.28 m (10.75 ft)

Length:
overall, rotors turning: 17.68 m (58.00 ft)
fuselage: 13.87 m (45.00 ft)
Width overall: 3.28 m (10.75 ft)

AH-1W shows its armament options (Bell Helicopter Textron)

Bell AH-1W SuperCobra of the US Marine Corps (Bell Helicopter Textron)

Height:
to top of rotor head: 4.11 m (13.50 ft)
overall: 4.44 m (14.57 ft)
Ground clearance, main rotor turning: 2.74 m (9.00 ft)
Width over skids: 2.24 m (7.33 ft)

Weights
Weight empty: 4,634 kg (10,216 lb)
Mission fuel load (usable): 946 kg (2,086 lb)
Max useful load: 2,065 kg (4,552 lb)
Max take-off and landing weight: 6,690 kg (14,750 lb)

Performance (at max take-off weight, ISA)
Never exceed speed (VNE): 190 kts (352 km/h)
Max level speed at sea level: 152 kts (282 km/h)
Max cruising speed: 150 kts (278 km/h)
Rate of climb at sea level, OEI: 244 m (800 ft)/min
Service ceiling: more than 4,270 m (14,000 ft)
Service ceiling, OEI: more than 3,660 m (12,000 ft)
Hovering ceiling:
IGE: 495 m (1,624 ft)
OGE: 915 m (3,000 ft)
Range at sea level with standard fuel, no reserves: 317 n miles (587 km)

Power plant: 2 General Electric T700-GE-401 turboshafts, each rated at 1,285 kW (1,723 shp). Transmission rating 1,515 kW (2,032 shp) for take-off; 1,286 kW (1,725 shp) continuous
Fuel (JP5): Fuel is contained in two interconnected self-sealing rubber fuel cells in fuselage with a total usable capacity of 1,162 litres (306.8 US gallons). Gravity refuelling point in forward fuselage, pressure refuelling point in rear fuselage. Provision for carriage on underwing stores stations of 2 or 4 external fuel tanks, each of 291 litres (77 US gallons) capacity; or 2—378 litre (100 US gallon) tanks; or 2—100 and 2—77 US gallon tanks; large tanks on outboard pylons only

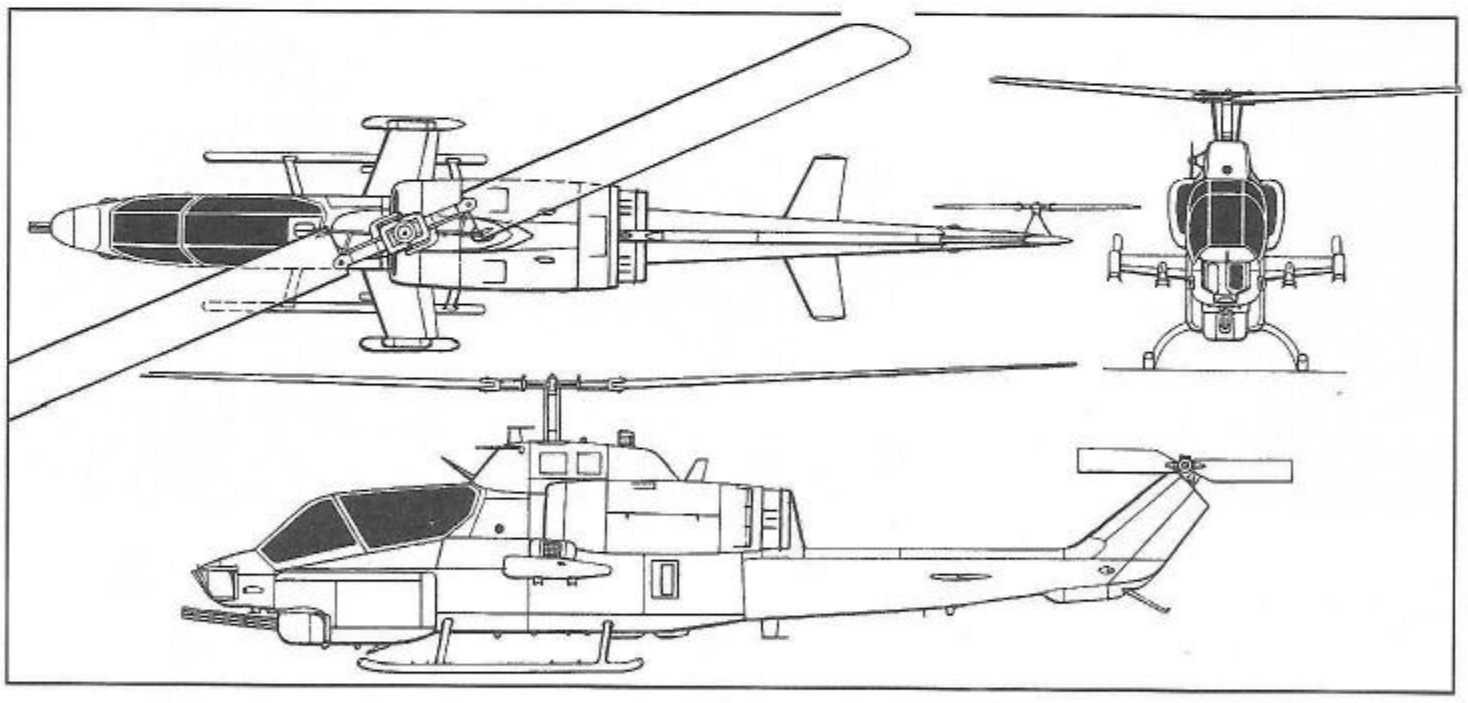
Accommodation: Crew of 2 in tandem, with co-pilot/gunner in front seat and pilot at rear

Avionics
Communications: 2 AN/ARC-182(V) radios, KY-58 TSEC secure voice set; AN/APX-100(V) IFF
Flight: AN/ASN-75B compass set, AN/ARN-89B ADF, AN/ARN-118 Tacan, AN/APN-154(V) radar beacon set, and AN/APN-194 radar altimeter, Teledyne AN/APN-217 Doppler-based navigation system with Collins CDU-800 control/display unit and dual Collins ICU-800 processors
Instrumentation: Kaiser HUD compatible with PNVS-5 and ANVIS-6 night vision goggles

Mission
Tamam/Kollsman Night Targeting System (NTSF-65), comprising FLIR, laser rangefinder/designator, TV camera, day/night video tracker and full in-flight boresighting

Self-Defence
AN/APR-39(V) pulse radar signal detecting set, AN/APR-44(V) CW radar warning system, and AN/ALQ-144(V) IR countermeasures set. Dual AN/ALE-39 chaff system with 1 MX-7721 dispenser mounted on top of each stub-wing. Improved countermeasures suite in USMC AH-1Ws will replace AN/APR-39 and AN/APR-44 by AN/APR-39(XE2) radar warning and adds AN/AVR-2 laser warner and AN/AAR-47 plume detecting set

Armament
M197 20 mm gun: Gun is housed in an electrically operated General Electric undernose A/A49E-7(V4) turret housing, with a 750-round ammunition container located in the fuselage directly behind it. Firing rate is 650 rds/min, with a 16-round burst limiter incorporated in the firing switch. Gun can be tracked 110° to each side, 18° upward, and 50° downward, but barrel length of 1.52 m (5 ft 0 in) makes it imperative that the M197 is centralised before wing stores are fired
Underwing attachments: Up to 4 LAU-61A (19-tube), LAU-68A, LAU-68A/A, LAU-68B/A or LAU-69A (7-tube) 2.75 in Hydra 70 rocket launcher pods; 2 CBU-55B fuel-air explosive weapons; 4 SUU-44/A flare dispensers; 2 M118 grenade dispensers; Mk 45 parachute flares; or 2 GPU-2A or SUU-11A/A Minigun pods. Up to 8 TOW missiles, 8 AGM-114 Hellfire missiles, 2 AIM-9L Sidewinder or AGM-122A Sidearm missiles can be carried on the outboard underwing stores stations. Canadian Marconi TOW/Hellfire control system enables AH-1W to fire both TOW and Hellfire missiles on same mission. Hughes AGM-65D Maverick capability demonstrated in 1990 is under consideration for USMC. It is planned to add 2 further pylons (total 6), with a proportional increase in weapons capability



Bell AH-1W SuperCobra (Jane's/Dennis Punnett)

FURTHER INFORMATION

PROGRAMME

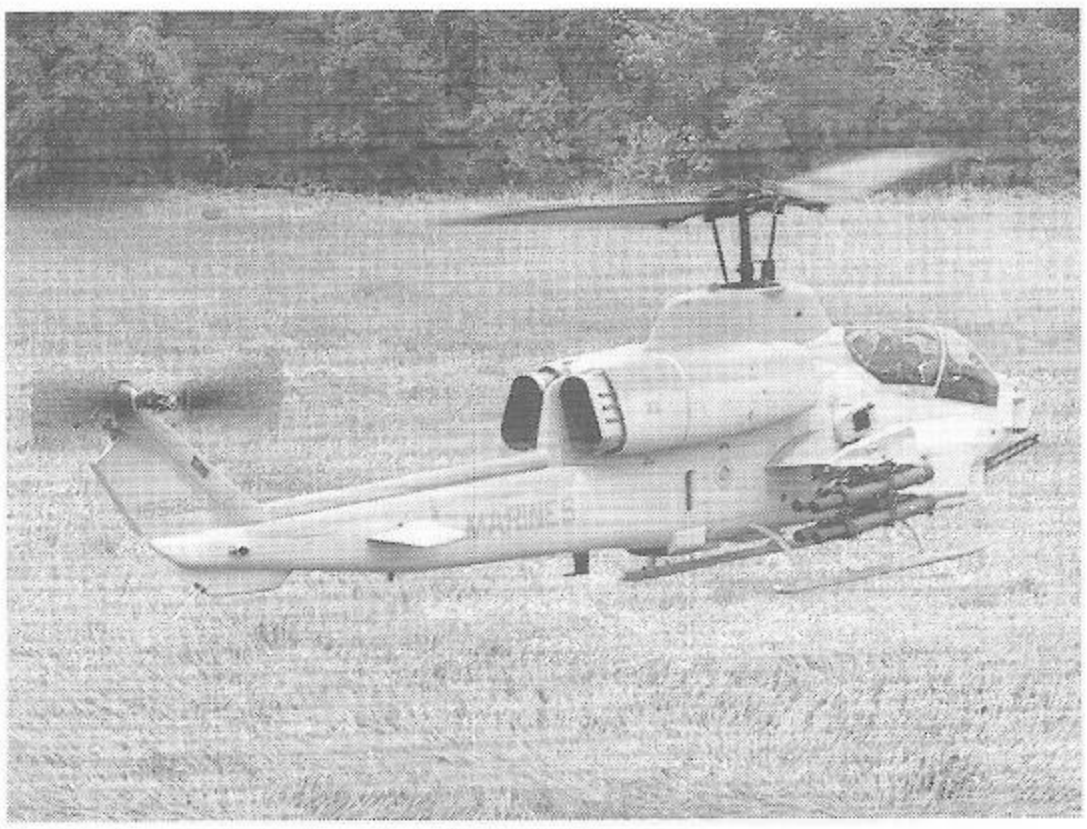
Descended from a long line of UH-1 and AH-1 designs, the AH-1W will continue to serve well into the next century. During 1980, Bell successfully flight-tested an AH-1T powered by two General Electric T700-GE-700 turboshafts with a combined output in excess of 2,386 kW (3,200 shp). A testbed helicopter, then designated AH-1T+, flew in November 1983, powered by two T700-GE-401s, and after successful reports it was ordered into production as the AH-1W. The first production machine was delivered in March 1986, with new-build aircraft being supplemented by 42 converted AH-1Ts. Unit cost was estimated to be $10.7 million at 1992 prices.

The missions of the AH-1W include anti-armour, escorting troop-carrying helicopters, multiple weapon fire support, armed reconnaissance, and search and target acquisition. A night targeting system is now being installed in all US Marine Corps AH-1Ws by Israel Aircraft Industries (IAI) (and also in Israeli-operated AH-1S). Maximum cruising speed is to be increased by 25 knots (46 km/h).

A programme designated AH-1W (IWS) (Improved Weapon System) was launched in 1993 but cancelled in 1995. Other improvement programmes include replacing the two-bladed rotor with a four-bladed design.

NAVAL OPERATORS

Taiwan: The Republic of China (Taiwan) signed a letter of offer and acceptance for 18 in February 1992 (of which nine were taken up in April 1993 and eight in FY95), plus 24 options.



Bell AH-1W SuperCobra (Bell Helicopter Textron)

A bearingless, four-bladed rotor would give the Upgrade Program AH-1W increased payload to 2,767 kg (6,100 lb) and raise the maximum speed to 210 knots, without any change in the T700-GE-401 engines (Bell Helicopter Textron)

Turkey: Turkish land forces received five AH-1Ws in 1990 and five in 1993, all of which had been diverted from USMC contracts.

USA: US Marine Corps planned to procure 190 AH-1Ws, but, although some 180 new-build/conversions were in service by mid-1995, this was reduced to 154 by the 1994 defence review. The US Marines are the only users to operate the type regularly at sea, with AH-1Ws forming part of the air wings aboard most US Navy amphibious warfare ships.

BOEING-VERTOL CH-46 SEA KNIGHT

AIRCRAFT

Role: Shipborne assault helicopter

In naval service: Canada (6); Japan (100); Saudi Arabia (17); Sweden (14); USA (297)

SPECIFICATIONS

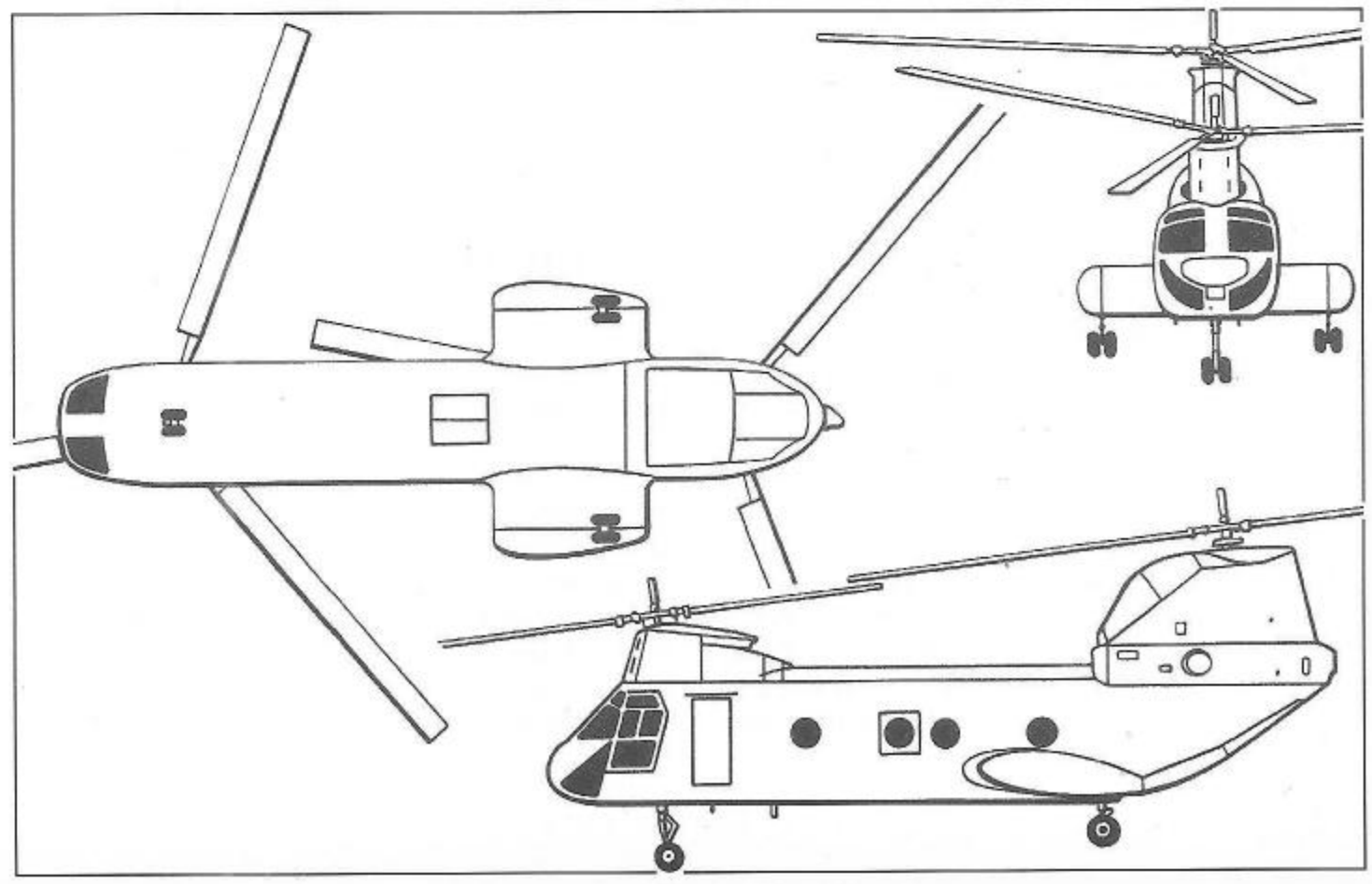
US Marine Corps CH-46E (Ash Amliwala)

Boeing CH-46E Sea Knight of USS Milwaukee (US Navy)

Dimensions (CH-46E)
Rotor diameter (each): 15.24 m (50.00 ft)
Fuselage length: 13.66 m (44.83 ft)
Height to top of rear rotor hub: 5.09 m (16.70 ft)
Passenger door:
height: 1.60 m (5.25 ft)
width: 0.91 m (3.00 ft)
Rotor disc area (total): 379.60 m² (4,086 sq ft)

Weights
Manufacturer's weight, empty: 5,927 kg (13,067 lb)
Max take-off weight: 10,433 kg (23,000 lb)

Performance
Max level speed at sea level: 144 kts (267 km/h)
Economic cruising speed: 134 kts (248 km/h)
Hovering ceiling (outside ground effect): 1,753 m (5,750 ft)



Boeing Vertol CH-46E Sea Knight
(Jane's/Mike Keep)

Hovering ceiling (inside ground effect): 2,895 m (9,500 ft)
Max range with standard fuel: 206 n miles (383 km)

Power plant: 2 General Electric T58-GE-10 turboshafts, each 1,394 kW (1,870 shp)
Accommodation: Pilot, co-pilot, crewman, plus 26 troops

Avionics
PTR 170 UHF radio/homer, and PV 141 standby UHF radio. Blind-flying instrumentation

FURTHER INFORMATION

PROGRAMME

Thirty-two years after the type first entered service, the CH-46 remains the standard assault helicopter of the US Marine Corps. Indeed, the current model in service – the CH-46E – is basically a CH-46D with workshop modifications made in the late 1970s. Thus, the airframes are considerably older than all but a very few of their aircrew and passengers.

Design work on the Vertol Model 107 began in 1956, with the first prototype flying in 1958. Following army and commercial orders, the first order from the US Marine Corps for the CH-46A was placed in 1961 and some 600 had been ordered by 1970. Production switched to the CH-46D in 1968, which was generally similar to the CH-46A but with more powerful engines and a new design of rotor blade. The CH-46Ds were later modified in service to CH-46E standard, with more powerful engines, crash-proof seats for the pilot and co-pilot, a more robust fuel system and an improved rescue system. The first of these was produced in 1977. The CH-46F was a revised production version of the CH-46D, with additional electronics. There are some 250 CH-46Es currently in service with the USMC and they will be found on any of the US Navy's amphibious assault ships.

Meanwhile, the US Navy became interested in the H-46 as a utility and search and rescue type. The first production version, the UH-46A, was similar to the marines' CH-46A and was specifically intended for the transfer of stores at sea (vertrep). This was followed by the UH-46D, which was similar to the US Marine Corps' CH-46D. Some 40 UH-46Ds remain in service with the US Navy.

KV-107: The Boeing Vertol 107 was produced under licence by Kawasaki in Japan as the KV-107. Some were delivered to the JMSDF but do not serve at sea. The Swedish Navy acquired 45 from Kawasaki in 1962-63 (designated Hkp 4C) primarily for ASW duties but these, too, only operate from land bases. Eight remain in service.

CH-113 Labrador: Six of this utility type were supplied to the Canadian Air Force under the designation CH-113 Labrador for search and rescue duties. All six remain but are land-based.

Boeing CH-46E Sea Knight of the US Marine Corps with Safety, Reliability and Maintenance (SR&M) refits

KAMAN SH-2G SUPER SEASPRITE

AIRCRAFT

Role: Shipboard anti-submarine, search and rescue, and general utility helicopter

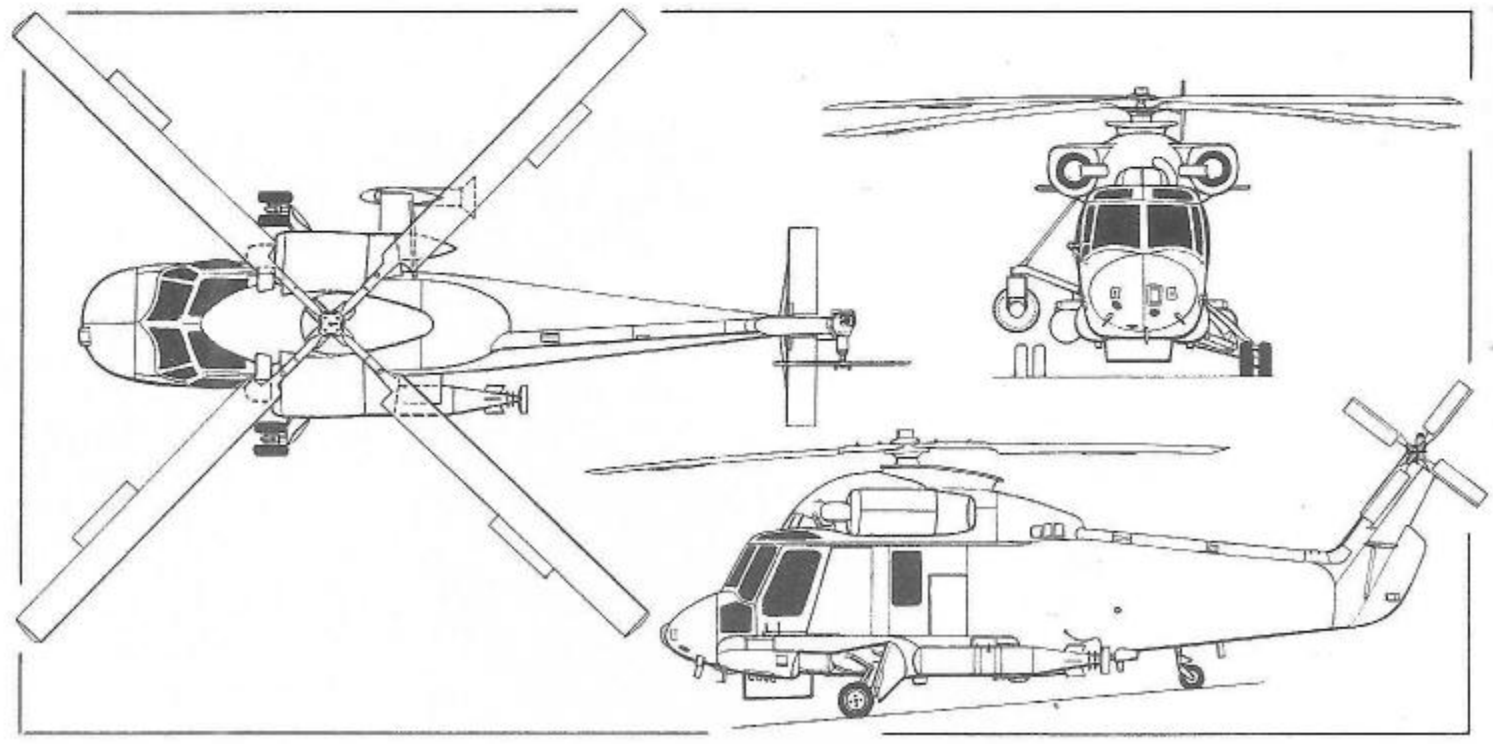
In naval service: Egypt (10); Taiwan (12); USA (16 plus 74 in reserve). (Possible future orders include: New Zealand (6); Thailand (6); and Turkey (12))

SPECIFICATIONS

Dimensions
Main rotor:
diameter: 13.51 m (44.33 ft)
disc area: 143.41 m² (1,543.66 sq ft)
Tail rotor:
diameter: 2.46 m (8.15 ft)
disc area: 4.77 m² (51.32 sq ft)
Length overall (both rotors turning): 16.08 m (52.75 ft)
Fuselage length: 12.19 m (40.00 ft)
Height to rotor head: 4.58 m (15.00 ft)

Weights
Empty: 3,447 kg (7,600 lb)
Max take-off: 6,124 kg (13,500 lb)

Performance
Max level speed at sea level: 138 kts (256 km/h)
Typical cruising speed: 120 kts (222 km/h)
Service ceiling: 7,285 m (23,900 ft)
Range with max standard fuel: 478 n miles (885 km)



Kaman SH-2G Super Seasprite LAMPS Mk 1 (Jane's/Dennis Punnett)

Power plant: 2–1,285 kW (1,723 shp) General Electric T700-GE-401 turboshafts. Normal fuel capacity 1,802 litres (476 US gallons)
Fuel: Basic fuel capacity of 1,802 litres (476 US gallons) incl up to 2 external auxiliary tanks with a combined capacity of 757 litres (200 US gallons).

Accommodation: Crew of 3 in ASW role (pilot, co-pilot/tactical co-ordinator, sensor operator. With LAMPS equipment removed can accommodate 4 passengers or 2 stretchers
Sensors (SH-2G/LAMPS I): Canadian Marconi LN-66HP surveillance radar; AN/ALR-66(V)1 radar warning/ESM; Teledyne Systems AN/ASN-150 tactical management system; dual Collins AN/ARC-159(V) UHF radios; Texas Instruments AN/ASQ-81(V)2 MAD; Computing Devices AN/USY-503 acoustic processor;

Flightline Electronics AN/ARR-84 sonobuoy receiver and AN/ARN--146 on-top position indicator. Tele-Dynamics AN/AKT-22(V)6 sonobuoy datalink; 15 DIFAR and DICASS sonobuoys. AN/ALE-39 chaff/flare dispensers; AN/ASQ-18B torpedo presetter. US Navy plans to install Hughes AN/ALQ-144 IR jammers; Loral AN/AAR-47 missile warning and Collins AN/ARC-182 VHF/UHF secure radio

Weapons: 1/2 Mk 46 or Mk 50 torpedoes; 8 Mk 25 marine smoke markers. Provision for pintle-mounted 7.62 mm MG in both doorways

FURTHER INFORMATION

PROGRAMME

This versatile helicopter has the unique distinction of having been put back into production to meet new US Navy orders. Originally designed in the mid-1950s, the Seasprite first flew in 1959 and 190 UH-2A and UH-2Bs were produced for use by the US Navy in the search and rescue, liaison, plane guard and utility helicopter. All were originally single-engined but were converted modified to twin-engine layout during their operational lives. In 1970 the helicopter was selected as the Interim LAMPS platform and 20 were converted to this configuration as SH-2Ds.

The definitive version was the SH-2F (LAMPS I), which had uprated engines, improved structure, performance and life, and operated at higher all-up weights. This enabled it to carry a Marconi LN66HP search radar, AN/ASQ-18 towed MAD and a tactical navigation/communications system, which necessitated a third crew member. A programme completed in 1982 brought 104 existing aircraft up to this new standard.

The first SH-2G flew in 1985 and was essentially an SH-2F with two General Electric T700-GE-701 engines which deliver some 10 per cent more power than the earlier T58s, together with 20 per cent less fuel consumption. In addition, new composite rotor blades are fitted. The SH-2G also has improved avionics and sensors and is able to undertake dipping sonar operations. Six new-build aircraft ordered by the US Navy were delivered in 1990-93 and it is planned to convert 90 existing SH-2Fs to the new standard.

Kaman SH-2F Seasprite in service with the US Navy Reserve

Kaman SH-2G of the US Navy, an upgraded SH-2F, powered by T700-GE-401 engines (Kaman)

NAVAL OPERATORS

Egypt: The Egyptian Navy has purchased 10 SH-2Fs, which will be upgraded to SH-2G standard prior to delivery. Designated SH-2G(E), their equipment will include Allied Signal AQ-18A dipping sonar. These will operate

Kaman SH-2F fitted with the Hughes AN/AAQ-16 FLIR (forward-looking infra-red) system in the white dome below the pilot's seat (Hughes)

from the two 'Knox' class frigates leased from the US Navy in 1994 and from the two 'Oliver Hazard Perry' class frigates to be leased in 1996/97.

New Zealand: In late 1995 the SH-25 reached the final bidding round in the New Zealand Navy's competition for a Wasp replacement, the only other surviving competitor being the Westland Super Lynx.

Taiwan: The RoC Navy took delivery of 12 ex-US Navy SH-2Fs in 1994, which will operate from the 1052 class frigates currently leased from the US Navy.

Thailand: There are reliable reports that negotiations for a purchase of SH-2Gs by the Thai Navy are under way. If successful, the aircraft would deploy aboard the 'Naresuan' class (PRC Type 25T), 'Chao Praya' class (PRC Type 053 HT/HT(H)) and 'Phutthayotfa Chulalok' class (US 'Knox' class) frigates.

USA: 16 SH-2F/Gs are in service with two US Navy Reserve squadrons, with some 74 in storage. The SH-2 has been replaced at sea by the SH-60 LAMPS III, but it would be unwise to conclude that this versatile, and capable aircraft might not return to front-line service in due course.

MCDONNELL DOUGLAS MD 500

AIRCRAFT

Role: Shipborne liaison and ASW helicopter

In naval service: Spain (10); Taiwan (10)

SPECIFICATIONS

Dimensions
Main rotor:
diameter: 8.03 m (26.33 ft)
disc area: 50.60 m² (544.63 sq ft)
Tail rotor:
diameter: 1.30 m (4.25 ft)
disc area: 1.32 m² (14.19 sq ft)
Fuselage length (rotors turning): 9.24 m (30.31 ft)
Fuselage: 7.01 m (23.00 ft)
Height to top of rotor: 2.48 m (8.14 ft)
Skid track: 2.06 m (6.76 ft)

Weights
Empty: 493 kg (1,088 lb)
Max take-off weight: 1,361 kg (3,000 lb)

Performance
Max level at 305 m (1,000 ft): 132 kts (244 km/h)
Economical cruise at optimum altitude: 117 kts (217 km/h)
Service ceiling: 4,390 m (14,400 ft)
Range: 267 n miles (606 km)
Max rate of climb at sea level: 384 m (1,260 ft)/min

Hovering ceiling:
in ground effect: 2,500 m (8,200 ft)
out of ground effect: 1,615 m (5,300 ft)

Power plant: 1 Allison 250-C18A turboshaft derated to 207 kW (278 shp) for take-off and 181 kW (243 shp) for continuous operation
Crew: 2 (pilot, co-pilot)
Sensors: Search radar, Texas Instruments MAD
Typical weapons loads: 1 Mk 46 torpedo or depth bomb

McDonnell Douglas (Hughes) MD 500ASW of the Spanish Navy (Albert Campanera Rovira)

McDonnell Douglas (Hughes) MD 500ASW (L J Lamb)

FURTHER INFORMATION

PROGRAMME

The Hughes company gained large orders from the US Army for the OH-6 Cayuse and the Model 500 was the civilian equivalent, but with a more powerful engine, increased fuel capacity and a revised cockpit and cabin arrangement. A military version was then developed as the Model 500M Defender, which was produced in the United States, Japan (Kawasaki) and Italy (Nardi). Large numbers of both civil and military versions of this helicopter are in use, but only two navies use them as shipboard aircraft.

NAVAL OPERATORS

Spain: The Spanish Navy operates 10 Hughes 500 MD/ASW, which are used as torpedo carriers for ASW operations, with secondary roles of search and rescue and surface search.

Taiwan: The Taiwanese Navy has 10 Hughes MD 500ASW, which are deployed aboard the 'Sumner' and 'Gearing' class destroyers.

MCDONNELL DOUGLAS MD900 EXPLORER

AIRCRAFT

Type: Eight-seat twin-engined light helicopter

In naval service: Mexico (10)

SPECIFICATIONS

Dimensions
Rotor:
diameter: 10.31 m (33.82 ft)
disc area: 83.52 m² (899.04 sq ft)
Length:
overall, rotor turning: 11.83 m (38.81 ft)
fuselage: 9.85 m (32.33 ft)
Fuselage width at cabin: 1.63 m (5.33 ft)
Height:
to top of rotor head: 3.66 m (12.00 ft)
to top of fins: 2.79 m (9.15 ft)
Min fuselage ground clearance: 0.38 m (1.25 ft)
Skid track: 2.24 m (7.33 ft)
Cabin door width: 1.27 m (4.17 ft)

Weights
Weight empty, standard configuration: 1,481 kg (3,265 lb)
Usable fuel load: 438-472 kg (965-1,041 lb)
Max internal payload: 1,163 kg (2,565 lb)
Max slung load: 1,361 kg (3,000 lb)
Max take-off weight:
internal load: 2,722 kg (6,000 lb)
slung load: 3,057 kg (6,740 lb)

Performance (at max take-off weight; ISA; A = PW206B engines; B = Arrius 2C engines
Never exceed speed (VNE) at sea level: 160 kts (296 km/h)
Max cruising speed at sea level, 38°C (100°F): 145 kts (267 km/h)
Max rate of climb at sea level: 853 m (2,800 ft)/min
Vertical rate of climb at sea level: 411 m (1,350 ft)/min
Rate of climb at sea level, OEI: 305 m (1,000 ft)/min
Service ceiling, both engines:
A: 5,490 m (18,000 ft)
B: 5,640 m (18,500 ft)
Service ceiling, OEI:
A: 3,200 m (10,500 ft)
B: 3,350 m (11,000 ft)
Hovering ceiling, in ground effect, ISA:
A: 3,900 m (12,800 ft)
B: 4,130 m (13,550 ft)
Hovering ceiling, in ground effect, ISA + 20°C:
A: 2,910 m (9,550 ft)
B: 2,970 m (9,750 ft)
Hovering ceiling, out of ground effect, ISA:
A: 3,445 m (11,300 ft)
B: 3,625 m (11,900 ft)
Hovering ceiling, out of ground effect, ISA + 20°C:
A: 2,165 m (7,100 ft)
B: 2,240 m (7,350 ft)
Hovering ceiling, OEI, in ground effect, ISA, 87% max take-off weight: 1,220 m (4,000 ft)
Max range at 1,525 m (5,000 ft), ISA: 286-315 n miles (529-584 km)
Max endurance: 3 h 18 min-3 h 30 min

Power plant
First 128 airframes: 2 Pratt & Whitney Canada PW-206Bs, each rated at 469 kW (629 shp) for 5 min for take-off
Later airframes: 2 Turbomeca TM319-2 Arrius 2Cs, each rated at 478 kW (641 shp) for 5 min for take-off
Transmission: 746 kW (1,000 shp) for 5 min for take-off, 671 kW (900 shp) max continuous, and 429 kW (575 shp) for 2.5 min OEI (1 engine inoperative)

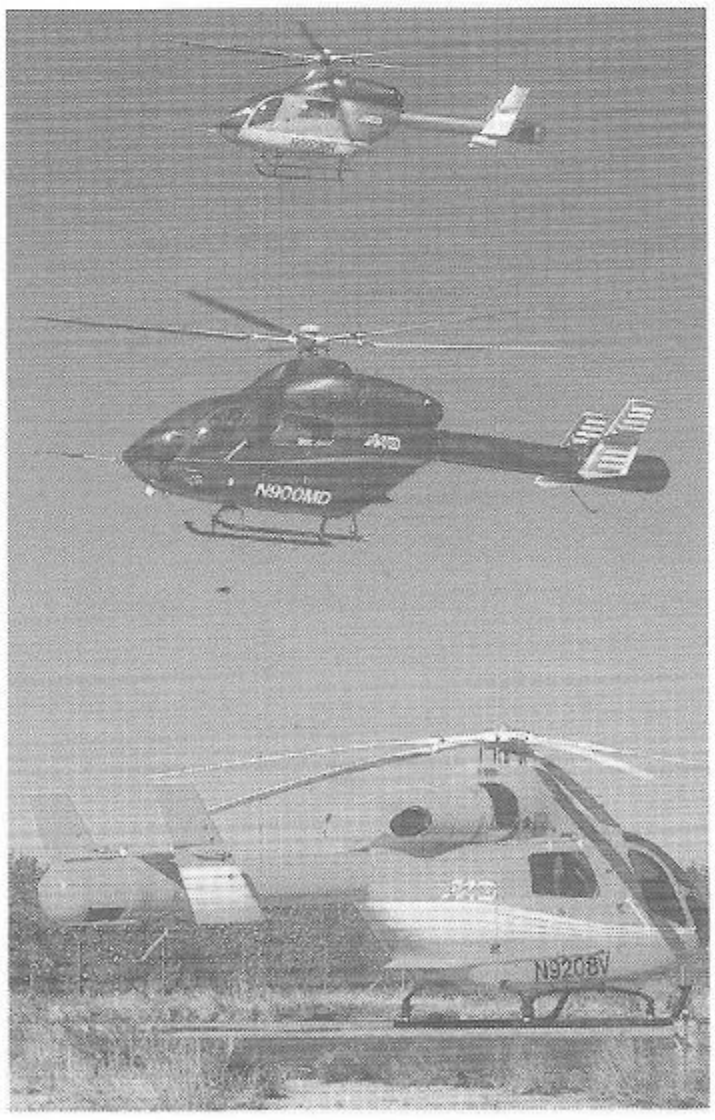
Fuel: 602 litres (159 US gallons) (useful capacity) in single tank under passenger cabin; optional 666 litres (176 US gallons); single-point refuelling; self-sealing fuel lines
Accommodation: 2 pilots or pilot and 1 passenger in front on energy-absorbing adjustable crew seats; 6 passengers

Avionics
Communications: Bendix/King Silver Crown VHF transceiver, audio control panel, ELT, cockpit voice recorder and Wulfsberg Flexcomm II optional
Radar: Weather radar optional
Flight: Full IFR capability for single- or 2-pilot operation. Optional equipment includes Bendix/King Silver Crown VOR/ILS, HSI, ADF, DME, marker beacon receiver, radar altimeter, Loran C and GPS. Coupled 3-axis auto-pilot optional

Equipment
Cargo hook with 1,361 kg (3,000 lb) capacity

Mission
Law enforcement panel with space for FLIR screen available

Company demonstrator for McDonell Douglas MD 900 Explorer eight-seat commercial prototype (McDonnell Douglas)



The three prototype MD 900s (McDonnell Douglas)

FURTHER INFORMATION

PROGRAMME

The MD 900/901 programme, now known simply as MD Explorer, was announced in February 1988, launched in January 1989 and led to the flight of a prototype in December 1992. The first delivery of a production airframe took place on 16 December 1994; 20 were delivered in 1995, rising to planned annual production rate of 48 in 1997, at a typical equipped price of $3.5 million, with a target direct operating cost of $375 per hour at 1994 prices.

The NOTAR (no tail rotor) system provides anti-torque and steering control without the need for an external tail rotor, a notoriously hazardous feature of other single main rotor designs. The tail rotor can strike trees, bushes, buildings and other objects around the landing pad, thus rendering the helicopter unserviceable. Alternatively, it is by no means unknown for people on the ground to walk into the rotating rear rotor, suffering at least bad wounds and frequently being killed. The NOTAR system eliminates this problem with the air, which is both cool and low velocity, being generated by a fan rotating at 5,388 rpm, and driven down the boom to the Coanda slots and ejected to counteract the

torque from the main rotor. A separate system pipes pressurised air to steering louvres in the rear of the boom, which are operated by the pilot's rudder pedals, and give control in yaw. This system would appear to be of especial benefit aboard small ships where cramped flight deck and numerous obstructions make the tail rotor a particular problem.

NAVAL OPERATORS

The only known current naval operator is the Mexican Navy which took delivery of 10 Combat Explorers in 1996 to replace its MBB 105 helicopters. These new helicopters will presumably take over the MBB 105's role as the shipboard helicopter for the 'Cuilahuac' (Fletcher) and 'Ilhuicamina' (Gearing) class destroyers and 'Hermenegildo Galeana' (Bronstein) class frigates.

NAVAL VARIANTS

The military version, the Combat Explorer, was displayed at Paris Air Show in June 1995. This can be configured for utility, medevac or combat missions and in the latter case armament may include seven- or 19-tube 70 mm rocket pods, 12.7 mm machine gun pods, chin-mounted FLIR night pilotage system and roof-mounted NightHawk surveillance and targeting systems. Combat weight will be 3,130 kg (6,900 lb) and the helicopter will be powered by two Pratt & Whitney of Canada PW206A engines.

The prototype Combat Explorer equipped with the NightHawk surveillance and targeting system above the cockpit, and the chin-mounted FLIR night pilotage system. It is armed with a 19-round 70 mm rocket launcher pod with a 12.7 mm machine gun pod inboard (McDonnell Douglas)

SIKORSKY SH-3 SEA KING

AIRCRAFT

Role: anti-submarine and general utility helicopter

In naval service: Argentina (7); Brazil (7); Canada (31); Italy (35); Japan (72); Spain (13); Thailand (14); USA (72)

SPECIFICATIONS

Dimensions
Main rotor diameter: 18.90 m (62.0 ft)
Length overall (both rotors turning): 21.91 m (71.88 ft)
Fuselage length: 16.69 m (54.75 ft)

Height to rotor head: 4.74 m (15.55 ft)
Rotor disc area: 280.5 m² (3,019 sq ft)

Weights
Empty: 5,601 kg (12,350 lb)

Max take-off: 9,525 kg (21,000 lb)
Internal cargo capacity: 2,720 kg (6,000 lb)

Performance
Never exceed speed (VNE): 144 kts (267 km/h)

UN Navy SH-3D (US Navy)

Spanish Navy SH-3G (F. Gomez)

Typical cruising speed: 120 kts (222 km/h)
Service ceiling: 3,720 m (12,200 ft)
Range with max standard fuel: 630 n miles (1,166 km)

Power plant: 2–1,118 kW (1,500 shp) General Electric T58-GE-100 turboshafts. Normal fuel capacity 3,180 litres (840 US gallons)
Accommodation: Crew of 4 in ASW role (pilot, co-pilot, 2 sonar operators)
Normal max accommodation:
troop lift: 31 passengers
casevac: 15 stretchers plus medical attendant
SAR: 25 survivors

Sensors
AS-3H (ASW): AQS-18/AQS-13F sonar; Doppler radar and ASW automatic navigation system; SMA/APS-707 radar with one/two transceivers; radio altimeter; marine markers, smoke floats. MAD and EW equipment can also be installed, according to user's requirements
SH-3G/H (US Navy): AN/APS-24 search radar; Bendix AQS-13 dipping sonar; TI ASQ-81(V)2 MAD, 25 sonobuoys

Weapons
ASW role: 2/4 torpedoes (A 244 AS; Mk 44; Mk 46) or 4 depth bombs
ASV role: 4 AS.12 medium-range missiles or 2 Marte Mk 2 or 2 Exocet AM 39 or 2 Harpoon

FURTHER INFORMATION

PROGRAMME

Sikorsky won a contract in 1957 to design an ASW helicopter, which resulted in the aircraft designated S-61 by the company and HSS-2 by the US Navy, although the latter was changed under the 'new' system to SH-3. Although designed for operation from US Navy carriers, the type has proved very adaptable, and is operated by many foreign navies from destroyer and frigate flight decks. It exists in many versions — ASW, ASV, SAR, transport and assault — and has been produced in Canada (United Aircraft of Canada), Italy (Agusta), Japan (Mitsubishi), and the UK (Westland).

The US Navy's force of SH-3s is now rapidly decreasing as they are replaced by SH-60s, but the type will continue in service for many years to come.

NAVAL OPERATORS

Current naval shipboard users are listed below:
USA: The US Navy has used the SH-3 for carrier battle group inner zone ASW, as well as for liaison and SAR, but the type is now rapidly being replaced by the SH-60F. Nevertheless, some seven SH-3G and 65 SH-3H remain in service in 1996.
Argentina: Argentina has five SH-3Ds and two SH-3H, which would serve afloat aboard the carrier *Veinticinco de Mayo* should it return to sea-going duty.
Brazil: The seven Brazilian SH-3D/Hs operate as the close in ASW element of the air wing aboard the carrier *Minas Gerais*.
Canada: Canada possesses 31 licence-built CH-124s, which operate from 'Iroquois' class destroyers, and 'City' and 'Annapolis' class frigates, using the RAST recovery gear. These were to have been replaced by the EH 101 Merlin, but that particular programme has been cancelled.
Italy: The Italian Navy has 35 SH-3Ds, most of which are shore-based. They also provide the ASW element of the air group aboard the carrier *Giuseppe Garibaldi*, but do not deploy aboard cruisers, destroyers or frigates.
Japan: The Japanese Maritime Self-Defense Force (JMSDF) has 72 Mitsubishi-built HSS-2B Sea Kings, which serve aboard all destroyers fitted with flight decks.
Spain: Spain has 10 SH-3D/G with AS-12 missiles, and 3 SH-3D converted to AEW role. All serve either ashore or aboard the carrier *Principe de Asturias*.
Thailand: The Thai Navy is to buy six SH-3s from Spain plus eight new-build SH-3s for use from the carrier *Chakri Naruebet*.

SIKORSKY CH-53E/MH-53E

AIRCRAFT

Type: Three-engined heavy-lift helicopter

In naval service: Japan (11); USA (254)

SPECIFICATIONS

Dimensions (CH-53E and MH-53E)
Main rotor:
diameter: 24.08 m (79. 0 ft)
disc area: 455.38 m² (4,901.7 sq ft)
Tail rotor:
diameter: 6.10 m (20.0 ft)
disc area: 29.19 m² (314.2 sq ft)
Length overall:
rotors turning: 30.19 m (99.05 ft)
rotor and tail pylon folded: 18.44 m (60.5 ft)
Length of fuselage: 22.35 m (73.33 ft)
Width of fuselage: 2.69 m (8.83 ft)
Width overall, rotor and tail pylon folded:
CH-53E: 8.66 m (28.41 ft)
MH-53E: 8.41 m (27.59 ft)
Height:
to top of main rotor head: 5.32 m (17.45 ft)
tail rotor turning: 8.97 m (29.43 ft)
rotor and tail pylon folded: 5.66 m (18.57 ft)
Wheel track (c/l of shock-struts): 3.96 m (13 ft 0 in)
Wheelbase: 8.31 m (27 ft 3 in)

Weights
Weight empty:
CH-53E: 15,072 kg (33,228 lb)
MH-53E: 16,482 kg (36,336 lb)
Internal payload (100 n miles; 185 km):
CH-53E: 13,607 kg (30,000 lb)
External payload (50 n miles; 92.5 km radius):
CH-53E: 14,515 kg (32,000 lb)
Max external payload:
CH-53E: 16,330 kg (36,000 lb)
Useful load, influence sweep mission:
MH-53E: 11,793 kg (26,000 lb)
Max take-off weight (CH-53E and MH-53E):
internal payload: 31,640 kg (69,750 lb)
external payload: 33,340 kg (73,500 lb)

Performance
CH-53E/MH-53E, ISA, T-O weight 25,400 kg (56,000 lb)
Max level speed at sea level: 170 kts (315 km/h)
Cruising speed at sea level: 150 kts (278 km/h)
Max rate of climb at sea level, 11,340 kg (25,000 lb) payload: 762 m (2,500 ft)/min

Sikorsky/Mitsubishi S-80M-1 Sea Dragon of the JMSDF (Hachiro Nakai)

CH-53D Sea Stallion of the US Marine Corps (Sikorsky)

Sikorsky MH-53E mine countermeasures helicopter towing an MCM sledge (US Navy)

Service ceiling at max continuous power: 5,640 m (18,500 ft)
Hovering ceiling at max power:
in ground effect: 3,520 m (11,550 ft)
out of ground effect: 2,895 m (9,500 ft)
Self-ferry range, unrefuelled, at optimum cruise condition for best range:
CH-53E: 1,120 n miles (2,074 km; 1,289 miles)

Power plant: 3 General Electric T64-GE-416 turboshafts, each with a max rating of 3,266 kW (4,380 shp) for 10 min, intermediate rating of 3,091 kW (4,145 shp) for 30 min and max continuous power rating of 2,756 kW (3,696 shp). Retrofit planned with T64-GE-419s, which is rated at 3,542 kW (4,750 shp). The transmission is rated at 10,067 kW (13,500 shp) for take-off.

Fuel
CH-53E: Self-sealing bladder fuel cell in forward part of each sponson, each with capacity of 1,192 litres (315 US gallons). Additional two-cell unit, with capacity of 1,465 litres (387 US gallons), brings total standard internal capacity to 3,849 litres (1,017 US gallons). Optional drop tanks outboard of each sponson have total capacity 4,921 litres (1,300 US gallons; 1,082 Imp gallons).
MH-53E: Nearly 3,785 litres (1,000 US gallons; 833 Imp gallons) extra fuel is carried in enlarged sponsons made of composites, bringing total internal capacity to 12,113 litres (3,200 US gallons). MH-53E can also carry seven internal range extension tanks, total capacity 7,949 litres (2,100 US gallons)

Accommodation: Crew of 3. Main cabin of CH-53E accommodates max of 55 troops. Door on forward starboard side of main cabin and hydraulically operated rear-loading ramp. Typical freight loads include 7 standard 1.02 × 1.22 m (3.33 ft × 4 ft) pallets. Single-point central hook for slung cargo, capacity 16,330 kg (36,000 lb)

Avionics
Flight: Hamilton Standard automatic flight control system, using two digital onboard computers and a four-axis autopilot. Retrofit test-flown late 1993, comprising four Canadian Marconi CM A-2082 15.2 cm (6 in) square colour displays, tied with GPS, Doppler and AHRS; installation by Teledyne Ryan.

Equipment
MH-53E equipment includes Westinghouse AN/AQS-14 towed sonar, AN/AQS-17 mine neutralisation device, AN/ALQ-141 electronic sweep, and Edo AN/ALQ-166 towed hydrofoil sled for detonating magnetic mines.

US Navy Sikorsky CH-53E Super Stallion heavy-lift helicopter (Paul Jackson)

FURTHER INFORMATION

PROGRAMME

The CH-53 prototype first flew in October 1964 to meet a US Marine Corps requirement for a heavy lift helicopter to replace the Sikorsky CH-37 Mojave. 141 of the original CH-53As were delivered, but none of these remains in service. CH-53Ds have more powerful engines, automatic blade-folding and increased cabin space and many remain in service with the US Marine Corps. All CH-53A/B/C/Ds together with the equivalent HH-53s, MH-53s and RH-53s are 'first-generation' aircraft, with twin engines, a six-bladed rotor and a vertical fin.

The CH-53E Super Stallion, however, was designed to carry substantially heavier loads, and its external differences with the earlier models are a third engine, seven-bladed main rotor and a very large, cranked fin and gull-wing stabiliser. The fuselage is also longer and fuel capacity greater. The first prototype flew in 1974, although deliveries to the US Marine Corps did not start until June 1981. 172 CH-53Es have been delivered up to and including FY95, but the programme's future is uncertain.

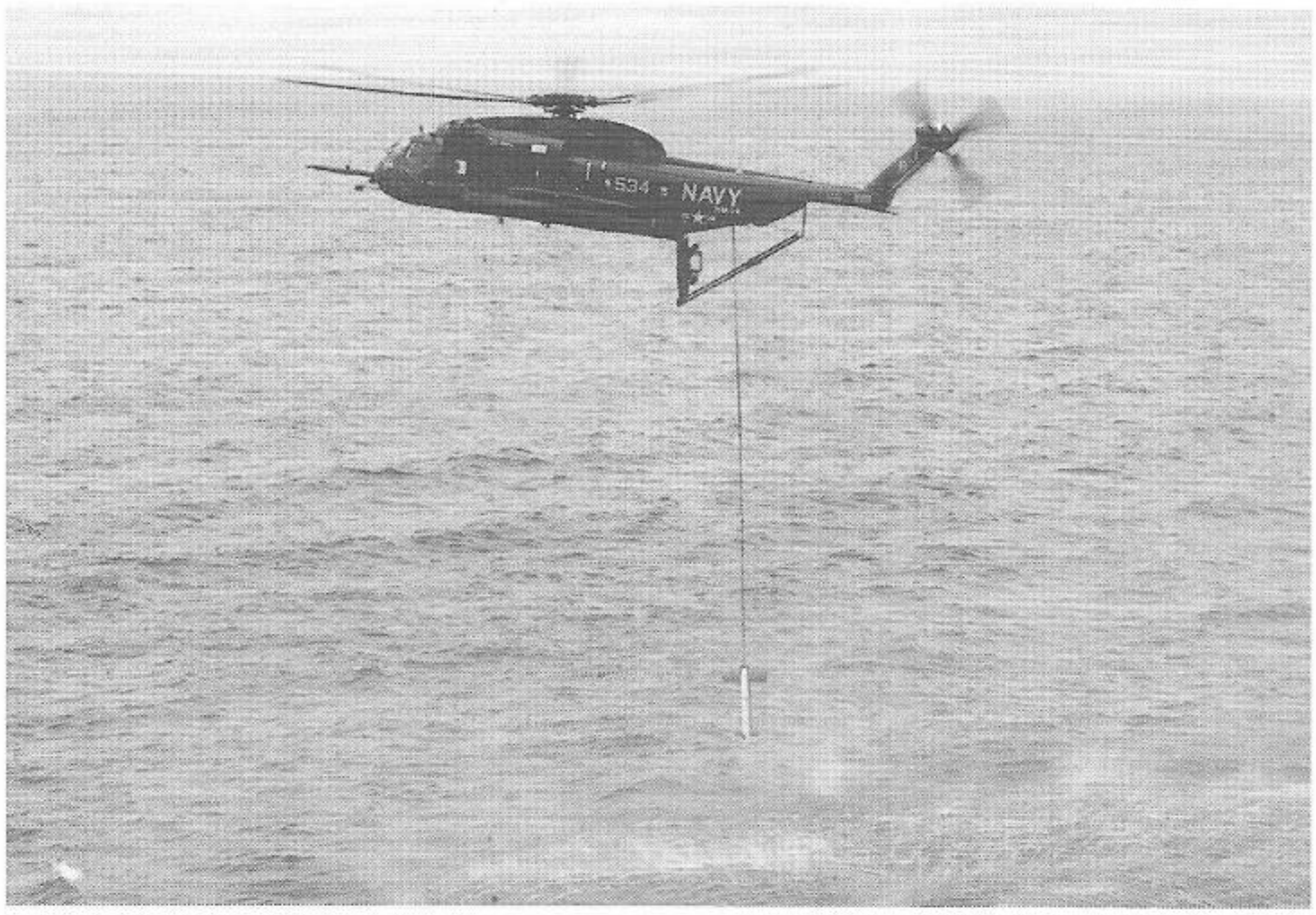
Planned improvements for the CH-53E include the use of composite materials in the tail-rotor blades, uprated GE T64-GE-416 engines, Omega navigation system, ground proximity warning system; flight crew night vision system, improved internal cargo-handling system, missile alerting system, chaff/flare dispensers, nitrogen fuel inerting system, and facility for refilling hydraulic system inside cargo compartment. Initial trials with AIM-9 Sidewinders have already taken place, with a view to giving the CH-53E an air-to-air self-defence capability.

Early interest was taken in the use of this very large helicopter for minesweeping and 15 CH-53As were transferred from the marine corps to the navy as RH-53As, and given T64-GE-413 engines. Even so, these were found to have insufficient power and were later returned to the marines and reconfigured as CH-53As. The navy then developed the RH-53D, which had T64-GE-415 engines, and was used in the MCM role for many years, although the type's most famous moment came in its use from USS *Nimitz* for the abortive Delta Force rescue raid on Tehran (Operation Eagle Claw).

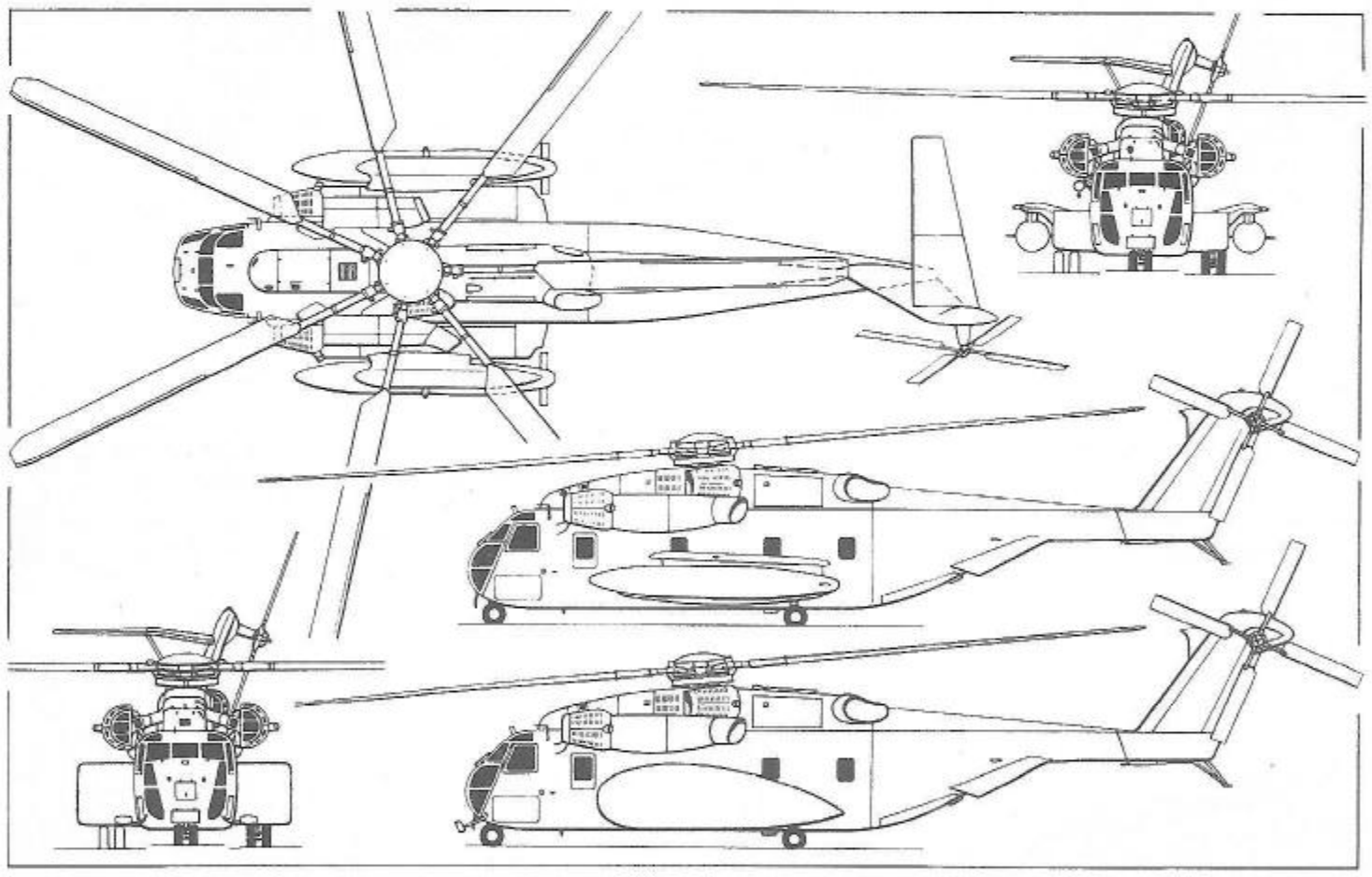
An MCM version of the -E model, designated MH-53E Sea Dragon, entered service in 1986 and by 1996, 48 out of a planned 50 had entered service. The minehunting equipment is little changed from that of the RH-53D, but huge sponsons house sufficient fuel for greatly extended MCM operations.

In 1993-94 one MH-53E was fitted with T64-GE-419 engines, which resulted in considerable performance gains, especially in recovery and flyaway capability in the event of engine failure in the hover. It is planned to retrofit the entire MH-53E fleet, the first eight engine kits being due for delivery in October 1996.

The CH-53E is a very expensive aircraft, unit cost at 1992 prices being estimated as $24.36 million.



MH-53E with AQS-14 sledge about to enter the water (Northrop Grumman)



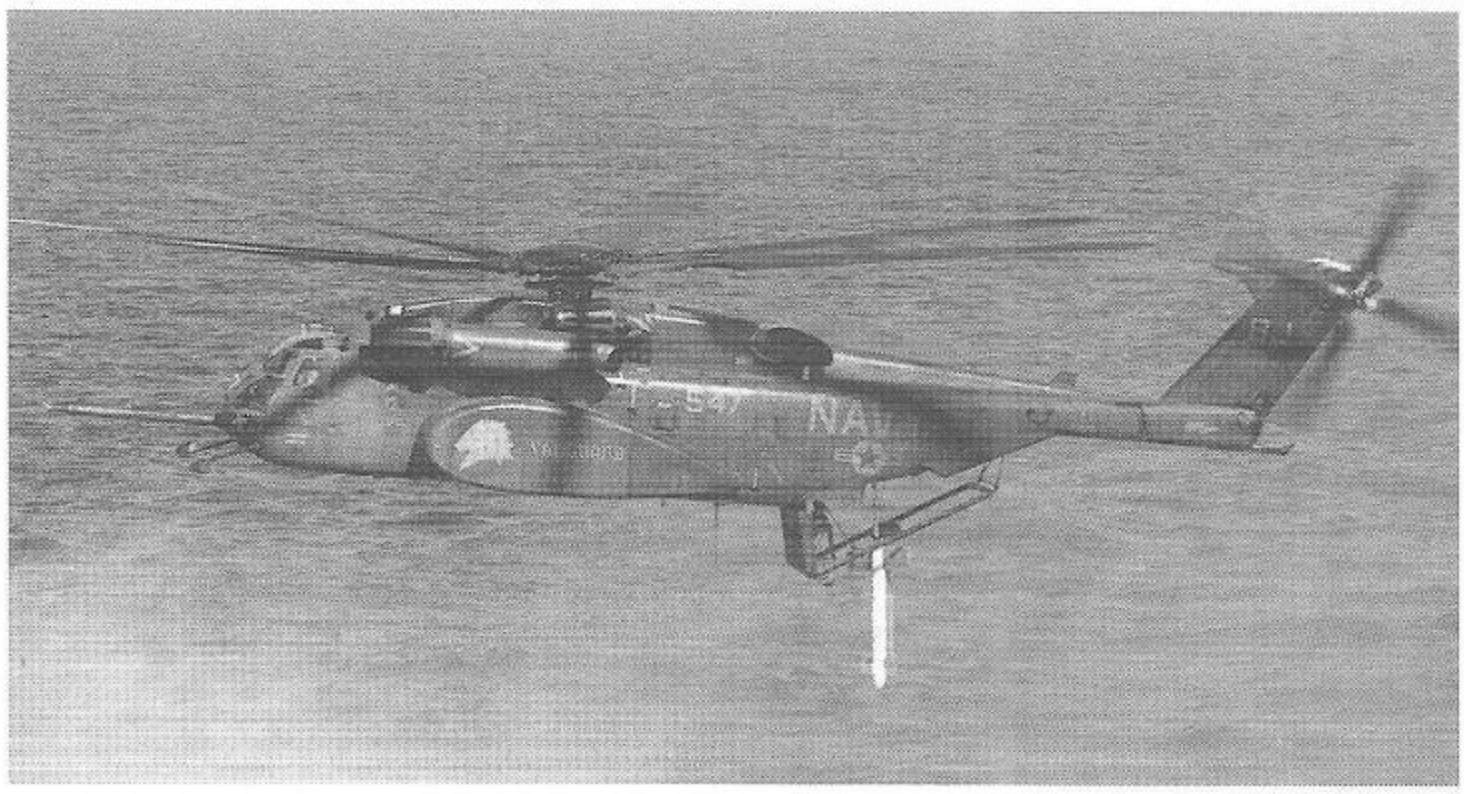
Sikorsky CH-53E Super Stallion, with additional side view and lower front view of MH-53E Sea Dragon (Jane's/Dennis Punnett)

NAVAL VARIANTS

CH-53E Super Stallion: The transport version is used by the US Marine Corps for amphibious assault, and, particularly, for carrying heavy equipment and armament, as well as recovering disabled aircraft. The aircraft is also used by the US Navy for vertical onboard delivery (vertrep) and the recovery of damaged aircraft from aircraft carriers.

MH-53E Sea Dragon: This airborne mine countermeasures (MCM) helicopter is able to tow a hydrofoil sledge through water, carrying mechanical, acoustic and magnetic sensors. It is equipped with improved hydraulic and electrical systems, together with minefield, navigation and automatic flight control system, with automatic towing and approach and departure from hover modes. The first flight of the first preproduction MH-53E took place in September 1983, with the first delivery to US Navy in June 1986. 32 had been delivered to USN by December 1991. Total requirement was 56. Delivery effected 1994 of MH-53E retrofitted with upgraded avionics package by EER Systems, comprising two 15.2 cm (6 in) horizontal situation display colour screens, Fairchild mission data loader and Rockwell Collins GPS 3A; USN developmental testing began June 1994 and an upgrade of entire MH-53E fleet planned but may be reduced to around 30 as result of defence budget trimming.

S-80M-1: The Japanese Maritime Self-Defense Force (JMSDF) purchased eleven aircraft, which are designated S-80M-1 by Sikorsky. They are virtually identical to the US Navy's MH-53E, but do not have a refuelling probe. The first was delivered in November 1989 and the eleventh in May 1994.



MH-53E comes into the hover and prepares to launch its AQS-14 minehunting sonar (Northrop Grumman)

SIKORSKY SH-60B SEAHAWK

AIRCRAFT

Type: ASW, anti-ship surveillance and targeting helicopter

In naval service: Australia (16); Greece (8); Japan (35 (plus 55 on order)); Spain (12); Taiwan (14); Thailand (6 ordered); USA (SH-60B – 188, SH-60F – 82, HH-60H – 42)

SPECIFICATIONS

Dimensions (SH-60B)
Main rotor:
diameter: 16.36 m (53.66 ft)
disc area: 210.15 m² (2,262 sq ft)
Tail rotor:
diameter: 3.35 m (11.00 ft)
disc area: 8.83 m² (95.03 sq ft)
Length overall:
fuselage: 15.26 m (50.0 ft)
rotors turning: 19.76 m (64.83 ft)
rotors/tail pylon folded: SH-60B – 12.47 m (40.91 ft); HH-60H – 12.51 m (41.04 ft)
Width, rotors folded: 3.26 m (10.69 ft)
Height:
to top of rotor head: 3.79 m (12.43 ft)
overall, tail rotor turning: 5.18 m (17.0 ft)
overall, pylon folded: 4.04 m (13.25 ft)
Wheelbase: 4.83 m (15.85 ft)
Cabin doors (each):
height: 1.37 m (4.5 ft)
width: 1.75 m (5.75 ft)

Weights
Empty:
SH-60B ASW: 6,191 kg (13,648 lb)
HH-60H: 6,114 kg (13,480 lb)
Internal payload:
HH-60H: 1,860 kg (4,100 lb)
Mission gross weight:
SH-60B ASW: 9,182 kg (20,244 lb)
Max gross weight:
SH-60B Utility, HH-60H: 9,926 kg (21,884 lb)
HH-60J: 9,637 kg (21,246 lb)

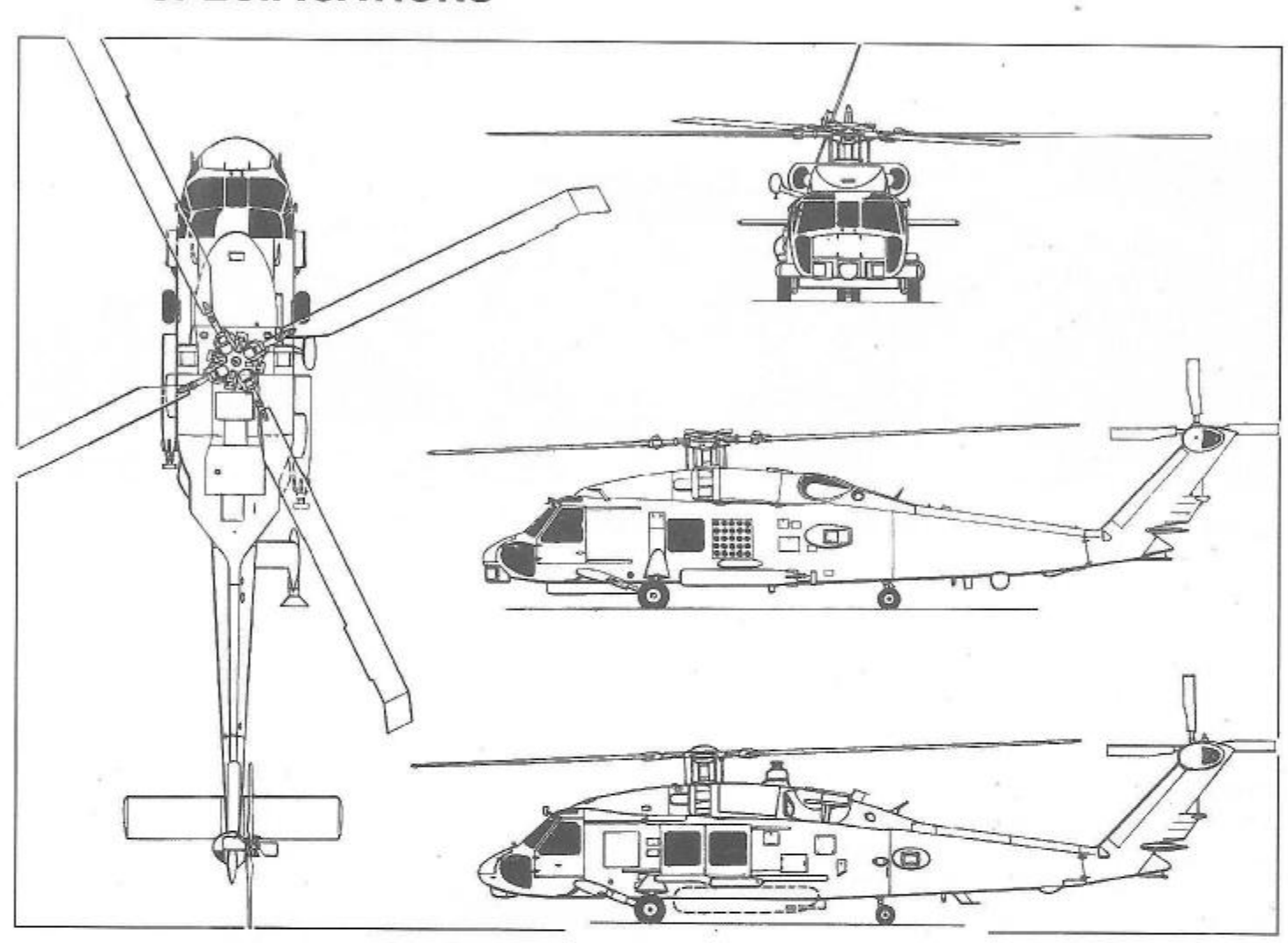
Performance
Cruising speed at sea level:
HH-60H: 147 kts (272 km/h; 169 mph)
Dash speed at 1,525 m (5,000 ft), tropical day
SH-60B: 126 kts (234 km/h)
Vertical rate of climb at sea level, 32.2°C (90°F):
SH-60B: 213 m (700 ft)/min

Power plant
SH-60B (pre-1988): 2 General Electric T700-GE-401 turboshafts rated at 1,260 kW (1,690 shp) 1,342 kW (1,800 shp)
SH-60B (1988 and after)/all SH-60F/HH-60H: 2 General Electric T700-GE-401C turboshafts rated at 1,417 kW (1,900 shp). Transmission rating 2,535 kW (3,400 shp)

Fuel:
internal: 2,233 litres (590 US gallons)
external: 2–455 litres (120 US gallon) auxiliary tanks on fuselage pylons (optional)

Accommodation: Pilot and airborne tactical officer/back-up pilot in cockpit, sensor operator in specially equipped station in cabin

Avionics (all except Japanese versions)
Communications: Collins AN/ARC-159(V)2 UHF, Collins AN/ARC-174(V)2 HF, Hazeltine AN/APX-76A(V) and Bendix/King AN/APX-100(V)1 IFF transponders, TSEC/KG-45(E-1) communications security set, TSEC/KY-75 voice security set, Telephonics OK-374/ASC communications system control group
Radar: Texas Instruments AN/APS-124 search radar (Thomson Thorn SuperSearcher for Australia; Telephonics AN/APS-128PC for Taiwan)



Sikorsky SH-60B Seahawk and HH-60H (bottom side view) (Jane's/Dennis Punnet)

S-70C(M)-1 of the Taiwanese Navy

Flight: Collins AN/ARN-118(V) Tacan, Teledyne Ryan AN/APN-127 Doppler, Collins AN/ARA-50 UHF DF, Honeywell AN/APN-194(V) radar altimeter

Mission
Sikorsky sonobuoy launcher, Edmac AN/ARR-75 and R-1651/ARA sonobuoy receiving sets (AN/ARR-84 receiver in Australian Seahawks and for USN Block 1 upgrade), Texas Instruments AN/ASQ-81(V)2 towed-MAD (CAE AN/ASQ-504(V) internal MAD in Australian Seahawks), Raymond MU-670/ASQ magnetic tape memory unit, Astronautics IO-2177/ASQ altitude indicator, Fairchild AN/ASQ-164 control indicator set, Fairchild AN/ASQ-165 armament control indicator set, IBM AN/UYS-1(V)2 Proteus acoustic processor (Computing Devices UYS-503 for Australia) and CV-3252/A

Japanese SH-60J is hauled down by the Indal Technologies RAST (recovery assist, secure and traverse) system (JMSDF)

converter display, Control Data AN/AYK-14 (XN-1A) digital computer, Raytheon AN/ALQ-142 ESM, Sierra Research AN/ARQ-44 datalink and telemetry (Rockwell Collins DHS-901 in Australian Seahawks). SH-60F has Bendix AN/AQS-13F dipping sonar (AN/AQS-18 in Taiwanese S-70s). During 1991 Gulf War, pod-mounted Hughes AN/AAQ-16 FLIR fitted to 5 SH-60Bs and Texas Instruments AN/AAQ-17 FLIR deployed on 1 SH-60B; GEC-Marconi Sea Owl IR turret evaluated later in 1991; Texas Instruments FLIR/laser designator under test on SH-60B in early 1994; option to procure 90 systems by 1997. Australian examples also acquired AN/AAQ-16 FLIR for Gulf War

Self-defence
Australian Seahawks fitted with AN/ALE-47 chaff/flare dispensers and AN/AAR-47 missile detectors for Gulf War

Avionics
SH-60J
Radar: Japanese HPS-104 search radar
Flight: Japanese automatic flight management system and ring laser gyro AHRS
Instrumentation: Japanese controls and displays subsystem, datalink and tactical data processor

Mission
Japanese HQS-103 sonar; Texas Instruments AN/ASQ-81D2(V) MAD; Ednac AN/ARR-75 sonobuoy receiver

Self-Defence
General Instruments AN/ALR-66 (VE) RWR; Japanese HLR-108 ESM

US Navy SH-60F Ocean Hawk passes close ahead of USS Theodore Roosevelt (US Navy)

Equipment
External cargo hook (capacity 2,722 kg; 6,000 lb) and rescue hoist (272 kg; 600 lb) standard

Armament
SH-60B, SH-60F: 2 Mk 46 torpedoes AGM-119B Penguin Mk 2 Mod 7 anti-shipping missiles. Block I upgrade integrates Penguin and Honeywell Mk 50 Advanced Lightweight Torpedo from 1993. Hellfire is being considered for attacking small ships
HH-60H: 2 pintle-mounted M60D machine guns but is to receive Rockwell AGM-114 Hellfire ASMs, 70 mm (2.75 in) rocket pods and forward-firing guns

FURTHER INFORMATION

PROGRAMME

The Sikorsky S-70 was developed as the naval element of the UTTAS program, which, in its land-based form resulted in the UH-60A Black Hawk utility helicopter. The S-70 also won the US Navy's LAMPS Mk III competition for a shipboard anti-submarine helicopter in 1977, the system giving 57 minutes more listening time on station and 45 minutes more ship surveillance and targeting time than LAMPS Mk I.

The first flight took place on 12 December 1979 and the first 18 SH-60Bs were authorised FY82. Changed USN planning in 1993 resulted in premature end to SH-60B/F production; SH-60F to be withdrawn from aircraft carriers; remanufacture of SH-60B/Fs as SH-60R to begin in 1998. It is reported that the unit cost of a US Navy SH-60B at 1992 prices was $20.25 million.

NAVAL VARIANTS

SH-60B: The US Navy model, this is deployed in 'Ticonderoga' class (CG-47) guided-missile cruisers, 'Spruance' class (DD-963) destroyers and 'Oliver Hazard Perry' (FFG-7) class frigates. SH-60Bs can land on, rearm and refuel from 'Arleigh Burke' class (Flights I and II) destroyers, but there are no hangar facilities. Full facilities will, however, be provided in 'Arleigh Burke' class (Flight IIA) and subsequent ships.
Mitsubishi/Sikorsky SH-60J Seahawk: Design work on a version of the Sikorsky SH-60B Seahawk to meet the JMSDF's requirement for an SH-3 Sea King replacement started in August 1983. The first XSH-60J prototype flew in August 1987 and the first production aircraft flew in May 1991. Airframe design is based

closely on that of the SH-60B and the aircraft is powered by two Ishikawajima-Harima T700-IHI-401C engines, which are licence-built versions of the GE T700, but Japanese avionics are installed. A new advanced main rotor system, featuring all-composite blades with a new aerofoil section, different planform and modified tips, is now under development. The Japanese Defence Agency's Technical Research and Development Institute assembled a prototype advanced rotor system for the SH-60J in 1995, with a full-scale version to be tested 1996-97. This will incorporate all-composite blades with redesigned cross-sections, planforms and tips and is expected to offer 5 per cent increase in hover efficiency and 30 per cent reduction in vibration levels; a fleetwide retrofit probable if trials successful. The total JMSDF requirement is for 90 aircraft.

S-70B: The Australian Navy selected Seahawk, designated S-70B-2, for its role-adaptable weapon system (RAWS) full-spectrum ASW helicopter requirement, for which an autonomous operating capability was essential. An order for eight was confirmed on 9 October 1984 and eight more were ordered in May 1986 for operations from the navy's 'Adelaide' class and 'MEKO' class frigates. The first ship's flight was formed in September 1991 and the squadron formally commissioned on 23 July 1992. The Australian S-70B-2 has substantially different avionics from the USN version: Thomson Thorn SuperSearcher radar (capable of tracking 32 surface targets) and Rockwell Collins advanced integrated avionics including cockpit controls and displays, navigation receivers, communications radios, airborne target hand-off datalink and tactical data system (TDS). The final delivery was made on 11 September 1991.

S-70B1: The Spanish Navy received six S-70B-1s from December 1988 (designated HS.23) for operation from four FFG-7 frigates by Escuadrilla 010 at Rota. These are similar to the USN's SH-60B, but with Bendix/King AN/AQS-13F dipping sonar. A further six were ordered 1991.

SH-60F Ocean Hawk: This was designed specifically for the Carrier (CV) Inner Zone ASW mission to replace the SH-3H Sea King, and is known as the 'CV-Helo'. Initial fleet deployment took place aboard USS *Nimitz* in 1991 and production ended with delivery of the final example on 1 December 1994. Plans have now, however, changed and the SH-60F is to be phased out of carrier operations and all surviving -Fs will be converted to SH-60R standard.

In the SH-60F all LAMPS Mk III avionics, fairings and equipment have been removed, including the cargo hook and RAST system main and tail probes, although the installation provisions have been retained. These have been replaced by integrated ASW mission avionics including Bendix AN/AQS-13F dipping sonar, MIL-STD-1553B databus, dual Teledyne Systems AN/ASN-150 tactical navigation computers and AN/ASM-614 avionics support equipment, automatic flight control system with quicker automatic transition and both cable and Doppler autohover. There is a tactical datalink with other aircraft, a communications control system, multifunction keypads and displays for each of four crew members. There is an extra weapon station to port enabling the helicopter to carry three Mk 50 homing torpedoes. There is also provision for surface search radar, FLIR, night vision equipment, passive ECM, MAD, an air-to-surface missile capability, sonobuoy datalink, chaff/sonobuoy dispenser, attitude and heading reference system (AHRS), Navstar GPS, fatigue monitoring system. All this requires an increase in maximum take-off weight to 10,659 kg (23,500 lb). Secondary missions for the SH-60F include search and rescue and plane guard.

HH-60H: This is the US Navy's strike-rescue and special warfare support helicopter and it is planned to acquire 42. The initial batch of 18 was completed in July 1991 and the second batch of 24 started with first delivery on 1 December 1994, There are two complete squadrons of HH-60H operated by the US Navy reserve, but in the regular force two HH-60Hs are included in each SH-60F squadron. The main mission of the HH-60H is to recover a four-man crew at 250 n miles (463 km) from the helicopter's launch point or to fly 200 n miles (371 km) and drop eight SEALs from 915 m (3,000 ft). The HH-60F is a close derivative of the SH-60F, with same T700-GE-401C engines and HIRSS as SH-60B/F. Equipment includes General Instrument AN/APR-39A(XE)2 RWR, Hughes AN/AVR-2 laser warning receiver, Honeywell AN/AAR-47 missile plume detector, Loral AN/ALE-47 chaff/flare dispenser, Sanders AN/ALQ-144 IR jammer, and a night vision goggle cockpit. Armament comprises two cabin-mounted M60D 7.62 mm machine guns and there is provision for weapon pylons, but development was authorised in October 1991 for the installation of Hellfire ASM, 70 mm (2.75 in) rockets and forward-firing guns. These helicopters are required to operate from the flight decks of FFG-7, DD-963, CG-47 and larger vessels, as well as from unprepared sites ashore. Cubic AN/ARS-6 personnel locator system is installed and some are equipped with Seahawk-type Indal RAST (recovery assist, secure and traverse) equipment.

SH-60R: This is a remanufactured SH-60B/F, which combines the SH-60B capabilities with the dipping sonar of the SH-60F. The original plan anticipated the first two conversions to be funded in FY98, followed by 15 in FY99 and more thereafter, but concerns over cost have led to a one year delay in launching the programme.

S-70B-6: This is a hybrid SH-60B/F for the Greek Navy for operation from the new MEKO 200 frigates, with five (plus three options) ordered on 17 August 1992. The armament will include NFT Penguin ASMs, while avionics include AN/AQS-18(V)-3 dipping sonar, AN/APS-143(V3) radar and AN/ALR-66(V)-2 ESM. The first two were delivered in the fourth quarter of 1994.

S-70B-7: This designation applies to the order for six Seahawks which is expected to be placed by the Thai Navy. This model will be equipped for coastal surveillance, maritime patrol and search and rescue missions from the new aircraft carrier, *Chakri Naruebet*. Deliveries are anticipated to start in 1997.

S-70C(M)-1 Thunderhawk: Delivery began July 1990 to Taiwanese Navy of 10 SH-60B Seahawks under the designation S-70C. These have been deployed since 1993 aboard the navy's six FFG-7 frigates. Equipment includes Bendix AN/AQS-18(V) dipping sonar, Telephonics AN/APS-128PC radar and Litton AN/ALR-606(V)-2 ESM integrated with radar antenna, but there is no MAD.

US Navy SH-60F Ocean Hawk deploys its Bendix AN/AQS-13F dipping sonar (US Navy)

DESIGN

SH-60B Seahawk was designed to provide all-weather detection, classification, localisation and interdiction of surface ships and submarines, either controlled through a datalink from the mother ship or operating independently; secondary missions include SAR, vertical replenishment, medevac, fleet support and communications relay.

Compared to the army's UH-60A, new features include more powerful navalised GE T700-GE-401 engines, additional fuel, sensor operator's station, 25 port-side internal sonobuoy launchers, pylon on starboard side of tailboom for MAD bird, lateral pylons for two torpedoes or external tanks, chin-mounted ESM pods, sliding cabin door, rescue hoist, electrically actuated blade folding, rotor brake, folding tail, short-wheelbase tailwheel landing gear with twin tailwheels stressed for lower crash impact, DAF Indal RAST recovery assist, secure and traversing for haul-down landings on small decks and moving into hangar, hovering in-flight refuelling system, and emergency flotation system; pilots' seats not armoured.

For operation in Gulf during Iran-Iraq war, 25 SH-60Bs fitted with upper and lower Sanders AN/ALQ-144 IR jammers, Tracor AN/ALE-39 chaff/flare dispensers, Honeywell AN/AAR-47 electro-optical missile warning, and a single 7.62 mm machine gun in door, for a weight penalty of 169 kg (369.5 lb); seven Seahawks fitted with Ford Aerospace AN/AAS-38 FLIR on port weapon pylon with instantaneous relay to parent ship.

MODERNISATION

Block I SH-60B update, introduced in production Lot 9, delivered from October 1991, includes provision for

The first S-70B-6 Seahawk was delivered to Greece in 1994 (Sikorsky)

NFT AGM-119 Penguin anti-ship missile, Mk 50 advanced lightweight torpedo, Rospatch AN/ARR-84 99-channel sonobuoy receiver (replacing ARR-75), Chelton AN/ARC-182 V/UHF FM radio and Rockwell Collins Class 3A Navstar GPS; prior to production cut-backs, 115 Penguin-capable Seahawks to come from retrofitting back to Lot 5.

Block II development, including airborne low-frequency sonar and inverse synthetic aperture radar, began 1991 with preliminary design contract awarded to IBM; EMD contract August 1993; for retrofitting from 1999; new sonar decision announced December 1991 in favour of Hughes/Thomson Sintra FLASH (folding light acoustic sonar for helicopters); 158 to replace AN/AQS-13F in SH-60F; plus 185 for installation in SH-60B; associated AT&T AN/UYS-2 enhanced modular signal processor; Telephonics multimode radar; improved version of AN/AYK-14 mission computer; improved ESM; maximum weight increased to 10,659 kg (23,500 lb).

FIXED-WING

DASSAULT (BREGUET) ALIZÉ

AIRCRAFT

Role: Naval, three-seat, carrier-based, anti-submarine aircraft

In naval service: France (21)

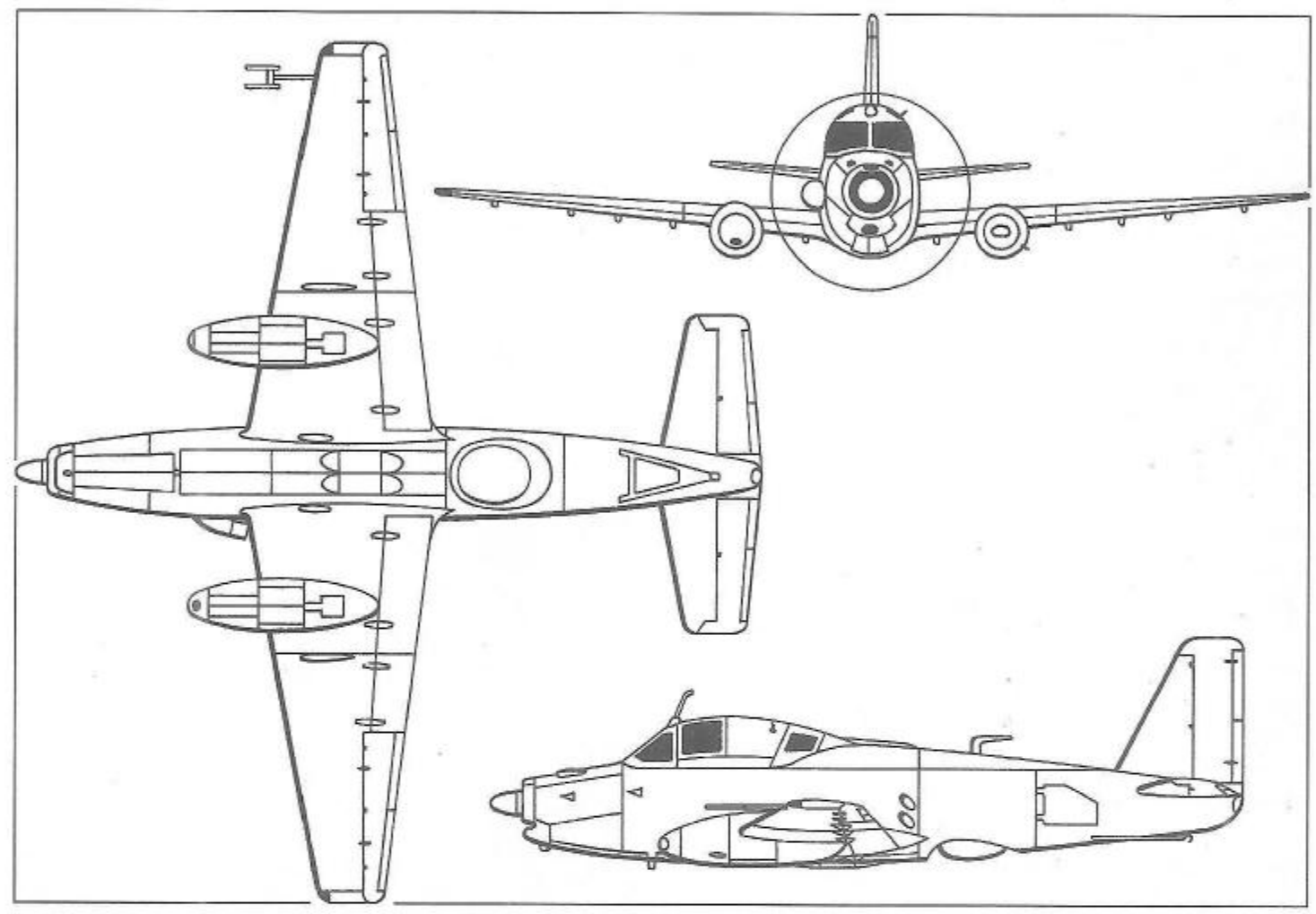
SPECIFICATIONS

Dimensions
Wing span: 15.60 m (51.17 ft)
Width (wings folded): 7.00 m (22.96 ft)
Length overall: 13.86 m (45.47 ft)
Height overall: 5.00 m (16.4 ft)
Wheel track: 4.87 m (15.98 ft)
Wing area: 36.00 m² (387.5 sq ft)

Weights
Empty, equipped: 5,700 kg (12,566 lb)
Max take-off: 8,200 kg (18,078 lb)

Performance
Max speed at sea level: 248 kts (460 km/h)
Max speed at 3,050 m (10,000 ft): 280 kts (518 km/h)
Ceiling: 8,000 m (26,250 ft)
Range: 1,349 n miles (2,500 km)
Normal endurance: 5 h 10 min

Accommodation: 3 (pilot, forward radar operator, rear radar operator)
Power plant: 1 Rolls-Royce Dart RDa 7 Mk 21 turbo-prop, rated at 1,473 kW (1,975 ehp), with Rotol 4-bladed variable-pitch propeller
Avionics: Iguane radar; ARAR 12A radar detector; Omega radio navigation aid; Thomson-CSF Chlio FLIR
Weapons: 1 homing torpedo, or 3—160 kg depth charges in weapons bay; plus 2—160 kg or 175 kg depth bombs, 127 mm (5 in) rockets, or 2—AS-12 missiles on underwing racks



Dassault (Breguet) Alizé (Jane's/Mike Keep)

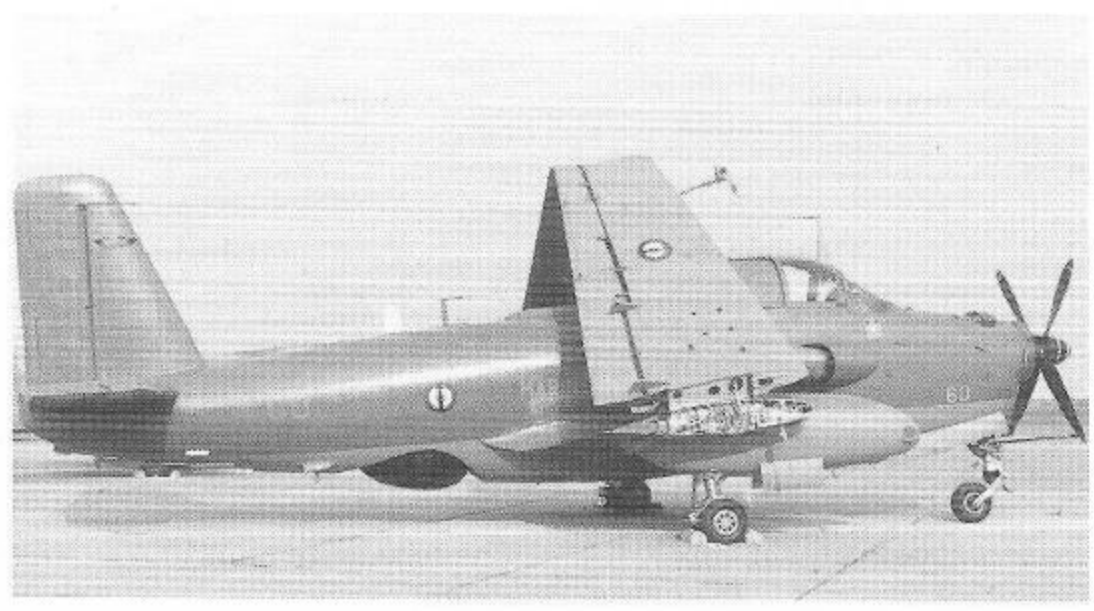
FURTHER INFORMATION

PROGRAMME

The prototype Breguet 1050 Alizé (Tradewind) flew on 6 October 1956, followed by the first production aircraft on 26 March 1959. 75 were produced for the French Navy, of which five were subsequently sold to the Indian Navy to supplement the 12 already bought by that country. In the early 1980s 28 of the French Alizés were modernised to BR 1150M standard and 24 of these were further refurbished in 1990. They are now reported to be due to remain in service until 2003.

Dassault (Breguet) Alizé of the French Aeronavale (Jane's/Paul Tompkins)

Alizé with bomb bay doors open and radar lowered (AMD/Aviaplans)



Alizé with wings folded; the type will have been in service for 40 years in 1999 (AMD/Aviaplans)

The air wing of both *Foch* and *Clemenceau* includes a squadron of six of these aircraft. Considering that they have undergone almost 40 years of carrier take-offs and landings, coupled with lengthy patrols at low level, the Alizé has shown the most remarkable durability.

OPERATIONAL

In the French Navy (Aeronavale), two flotilles (squadrons) remain: 4 F in the Atlantic Fleet and 6 F in the Mediterranean Fleet. These units have nine operational aircraft each, which provide six aircraft for each operational carrier. 6 F is also the operational conversion unit, for which it has an additional three aircraft. The type is no longer in service with the Indian Navy.

DASSAULT ETENDARD IVP

AIRCRAFT

Type: Single-seat, supersonic, carrier-based photographic reconnaissance aircraft

In naval service: France (11)

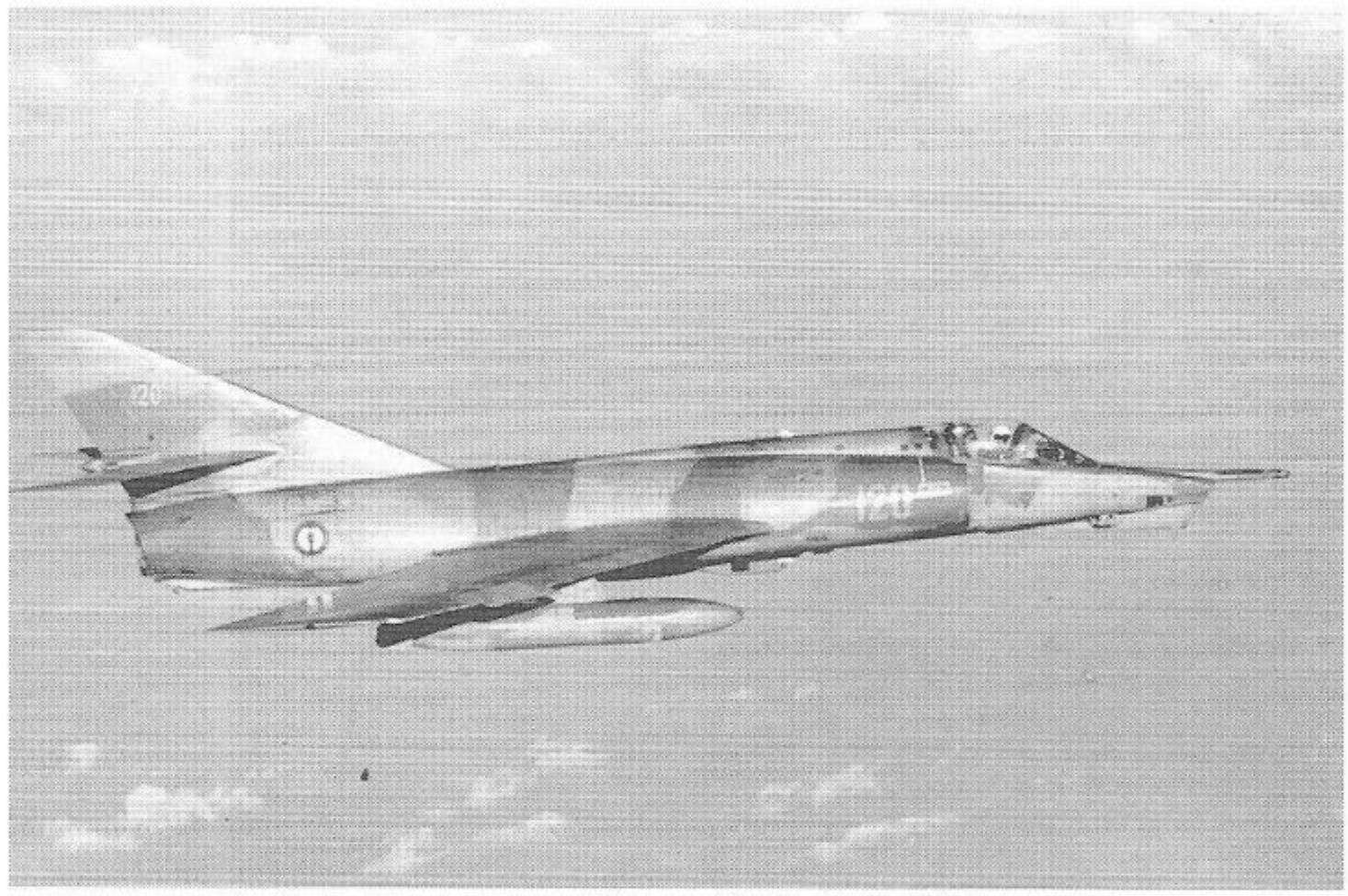
SPECIFICATIONS

Dimensions
Wing span: 9.60 m (31.50 ft)
Length overall: 14.50 m (47.57 ft)
Height overall: 3.85 m (12.66 ft)
Wing area: 28.43 m² (306 sq ft)

Weights
Empty: 5,900 kg (13,000 lb)
Take-off:
normal: 8,165 kg (18,000 lb)
max: 10,200 kg (22,486 lb)

Performance
Speed:
at 11,000 m (36,000 ft): Mach 1.02
at sea level: 1,099 km/h (683 mph)
Service ceiling: 10,668 m (35,000 ft)
Range: 750 n miles
Endurance:
internal fuel: 1.75 hours
with external tanks: 2.25 hours

Power plant: 1 SNECMA Atar 8B turbojet, rated at 43.16 kN (9,700 lb st)
Accommodation: 1 pilot
Sensors: 5 OMERA cameras; 3 in the nose and 1 in each of 2 ventral stations
Weapons: 100 mm and 68 mm rockets

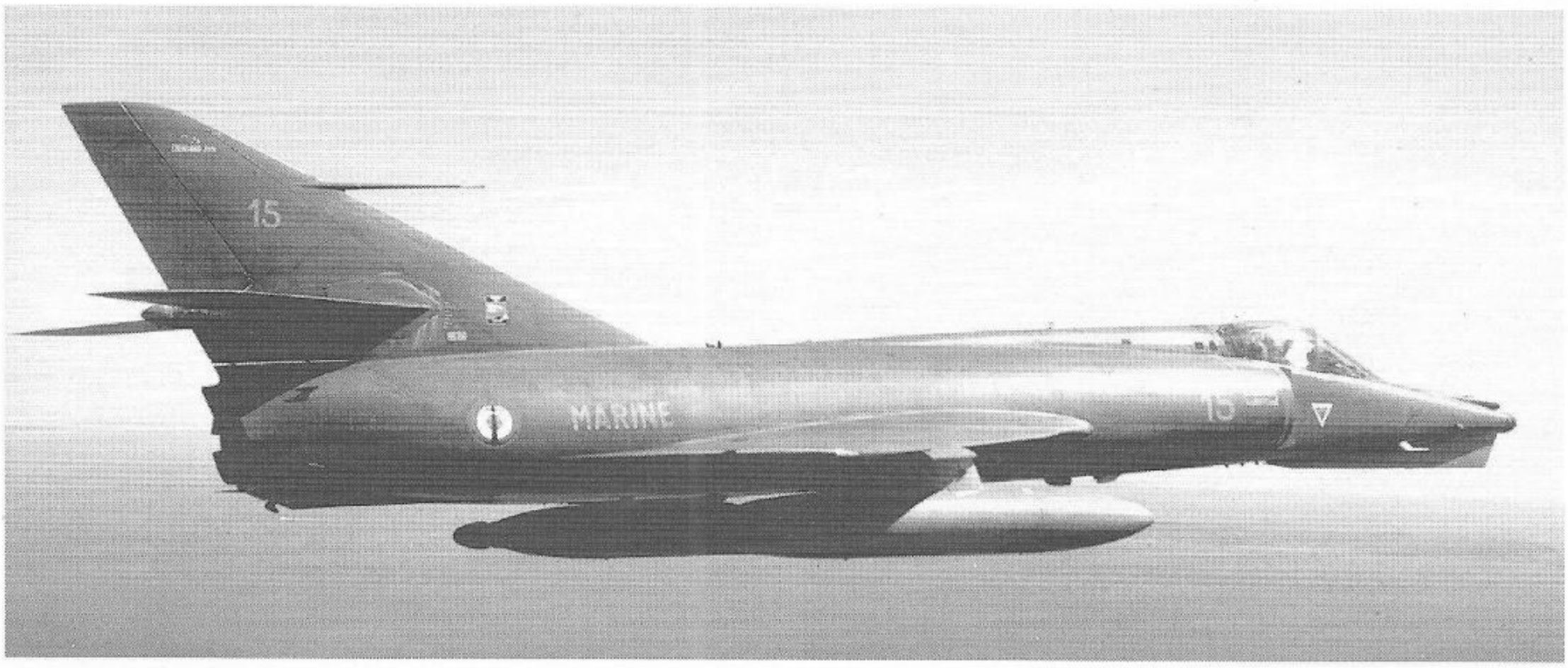


Etendard IVP with long-range tanks provides a French carrier task force with its reconnaissance capability (Marine Nationale)

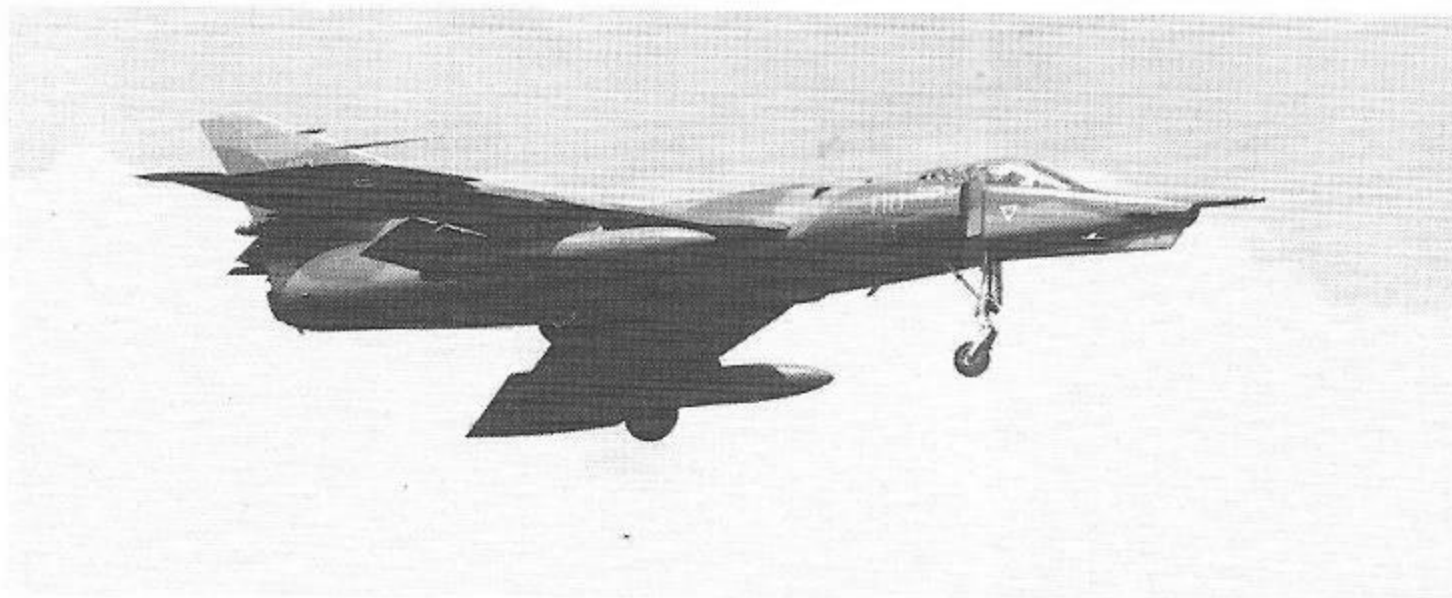
FURTHER INFORMATION

PROGRAMME

The original semi-navalised Etendard IVM-01 flew on 21 May 1958, followed by a number of preproduction aircraft during 1959-60. 69 strike fighters were ordered for the Aeronavale and delivered between 1962 and 1964. The Etendard IVM served with the French Navy until replaced by the Super Etendard in the years 1978-82. Meanwhile, an unarmed photographic reconnaissance version designated Etendard IVP first flew on 19 November 1960, carrying five OMERA Cameras, three of them in the nose in place of the strike aircraft's



Etendard IVM, the fleet strike fighter from which the IVP was developed (Dassault/B Thouanel)



Etendard IVP, reconnaissance aircraft of the French Navy. The undernose fin was installed in the original fighter version for a missile-guidance radar, long since discarded (Jane's/Paul Tompkins)

Aïda 7 fire-control radar. There is a fixed refuelling probe immediately above the nose and a 'buddy' refuelling pack can be carried beneath the fuselage. The first production Etendard IVP was completed in June 1962 and manufacture of the type ended in 1965 with the delivery of the 21st aircraft. An unusual feature of the aircraft is its undernose fin, which was inherited from the Etendard IVM, in which it housed an antenna for the guidance system for the AS.20 missile.

11 Etendard IVMs remain in service with Squadron 16 F based at Landivisiau. This unit provides detachments of four aircraft each to the two current carriers for photo reconnaissance/refuelling duties.

DASSAULT SUPER ETENDARD MODERNISE

AIRCRAFT

Type: Single-seat, transonic, carrier-based strike fighter

In naval service: Argentina (10); France (55)

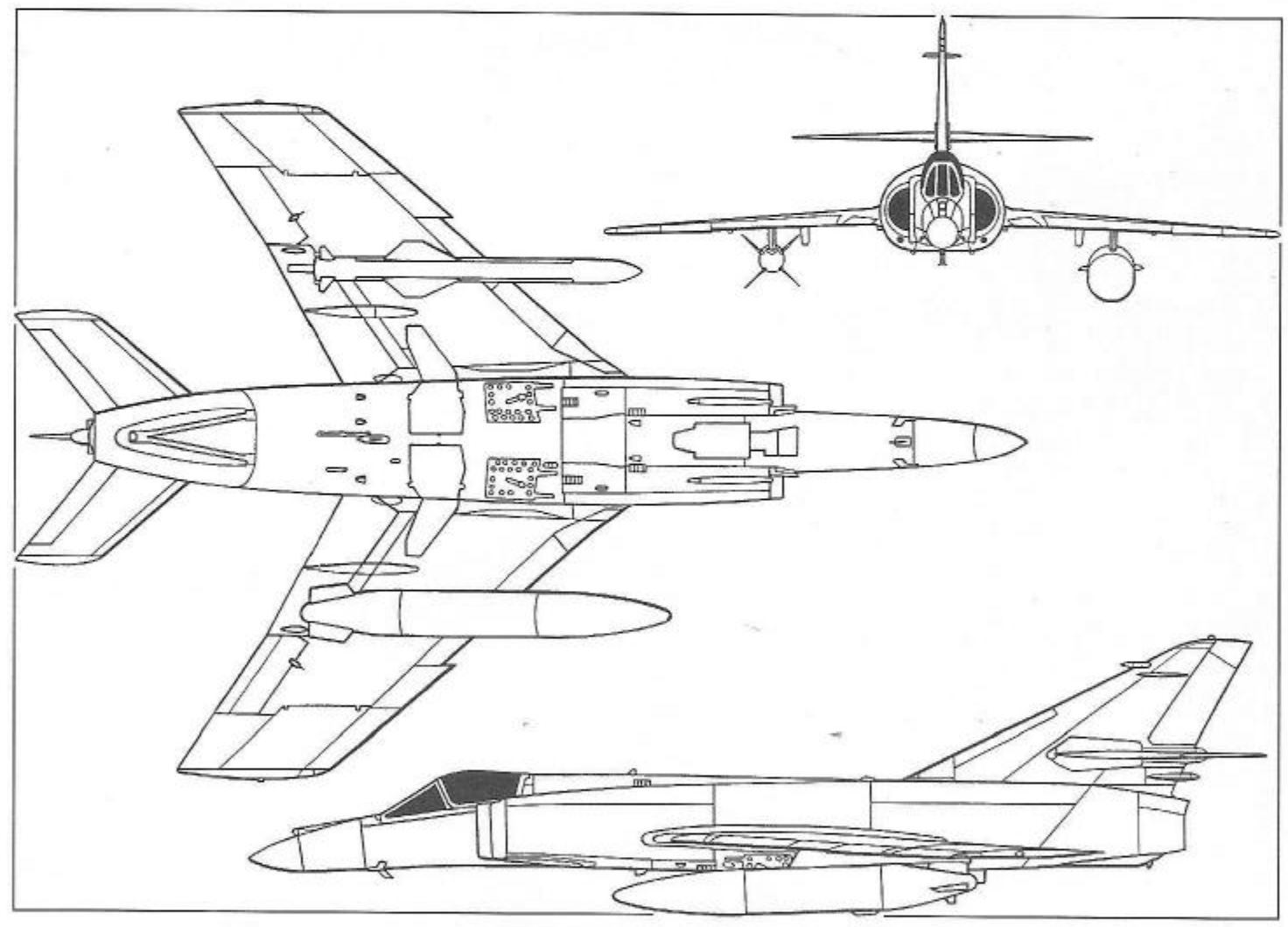
SPECIFICATIONS

Dimensions
Wing span: 9.60 m (31.50 ft)
Width (wings folded): 7.80 m (25.59 ft)
Length overall: 14.31 m (46.95 ft)
Height overall: 3.86 m (12.33 ft)
Wheel track: 3.50 m (11.50 ft)
Wing area: 28.4 m² (305.7 sq ft)

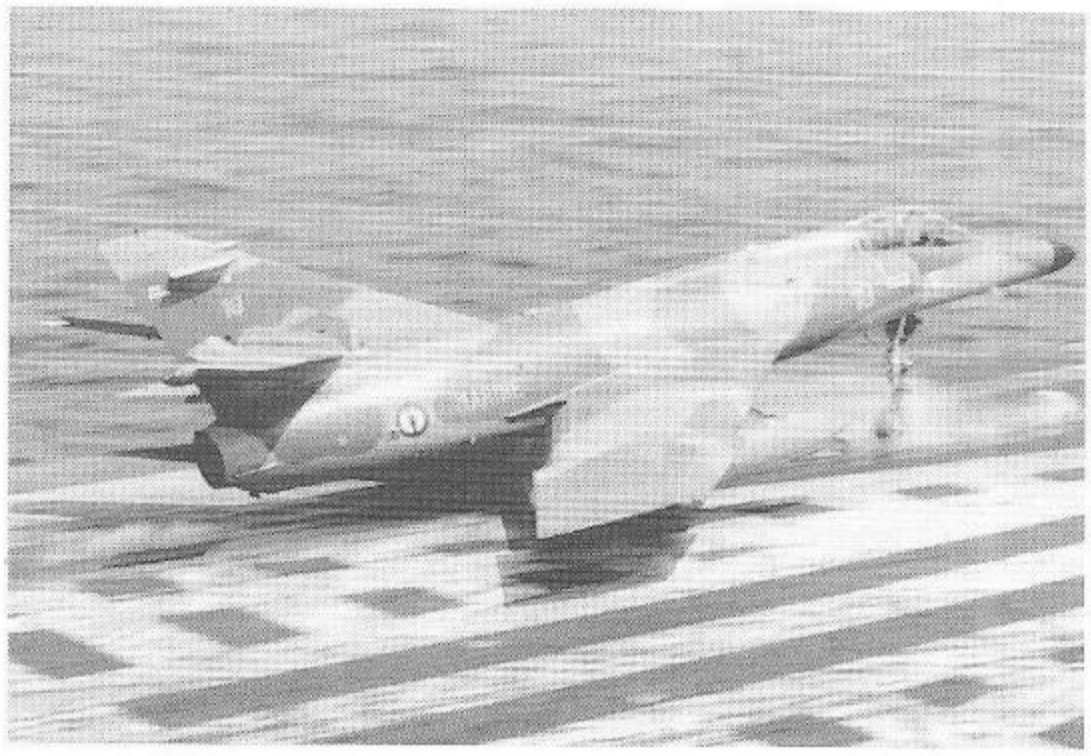
Weights
Empty: 6,500 kg (14,330 lb)
Max weapon load (internal fuel only): 2,100 kg (4,630 lb)
Mission take-off weight: 9,450-12,000 kg (20,833-26,455 lb)

Performance
Max speed at low altitude: 637 kts (1,180 km/h)
Max speed at altitude: Approx Mach 1
Approach speed for shipboard landing at 7,800 kg (17,200 lb) all-up weight: 135 kts (250 km/h)
Service ceiling: 13,700 m (45,000 ft)
Radius of action with AM39 missile and 2 external tanks; hi-lo-hi: 460 n miles (850 km)

Power plant: 1 SNECMA Atar 8K-50 non-afterburning turbojet, rated at 49 kN (11,025 lb st)
Fuel:
internal: 3,270 litres (845 US gallons)
external: 2—1,100 litre (290 US gallon) underwing tanks; 1 centreline 600 litre (158 US gallon) tank



Dassault Super Etendard (Jane's/Mike Keep)



Dassault Super Etendard (F Gamez)

Super Etendard lands aboard a French aircraft carrier, heavily laden with long-range tanks (AMD-BA/Aviaplans)

Super Etendards of the Argentine Navy. Two of these aircraft carried out the Exocet attack on the British destroyer HMS Sheffield, *changing the face of naval warfare* (AMD-BA/Aviaplans)

Accommodation: 1 pilot on Hispano-built Martin-Baker SEMMB CM4A lightweight ejection seat

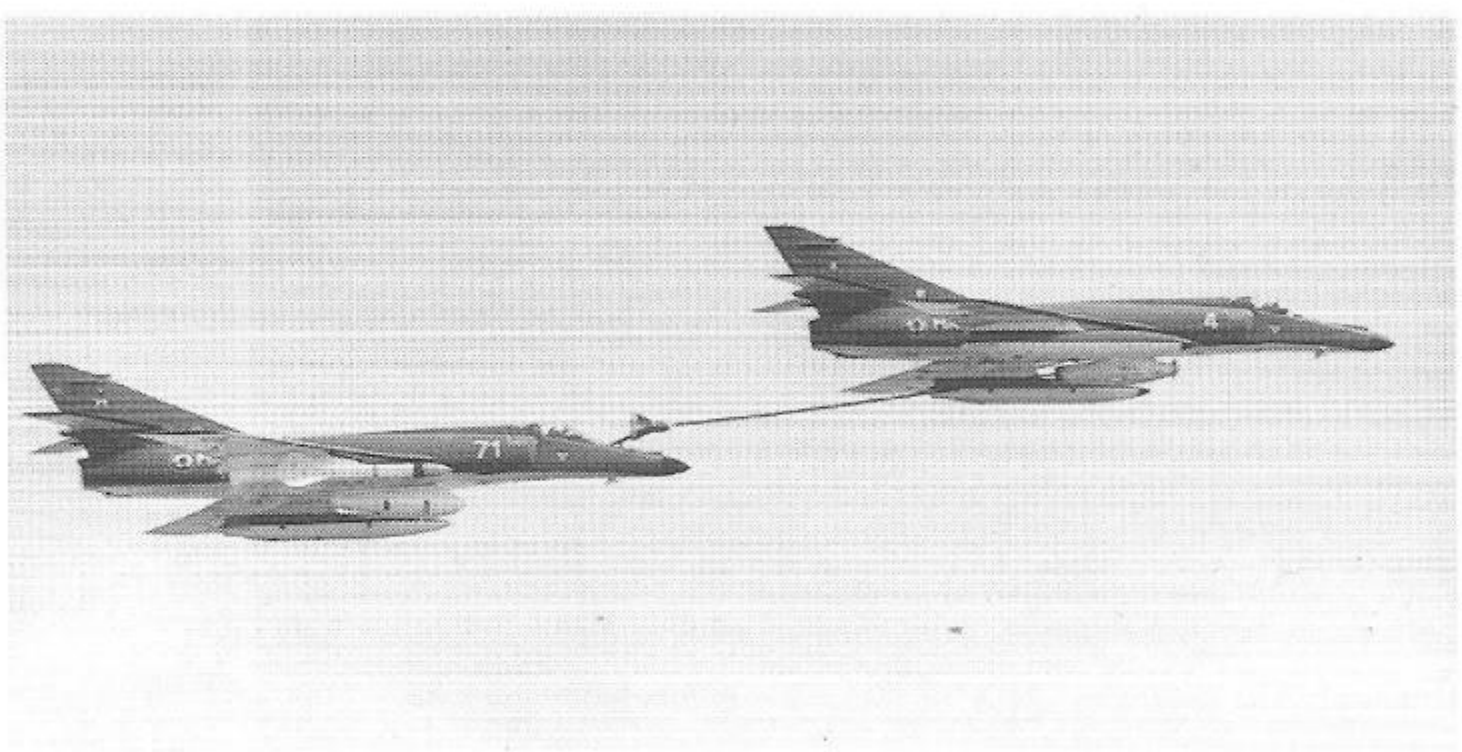
Sensors

SAGEM-Kearfott ETNA inertial navigation and attack system; Dassault Electronique Anémone lightweight search/track/designation/telemetry/navigation radar*; Thomson-CSF Sherloc radar warning receiver*; Barracuda jammer*; Alkan Type 5081 chaff/flare dispensers*; SAGEM UAT 90 computer*

* Being fitted in 1990-1997 Super Etendard Modernisé programme

Weapons

Two DEFA 30 mm guns, each with 125 rounds in bottom of air-intake trunks; underfuselage attachments for two 250 kg bombs; four underwing attachments for 400 kg bombs, MAGIC air-to-air missiles or rocket pods; one AM39 Exocet missile can be carried under starboard wing and one external fuel tank under port wing. ANT 52 nuclear weapons



French Super Etendards refuelling using the 'buddy-packs' system (AMD-BA/Aviaplans)

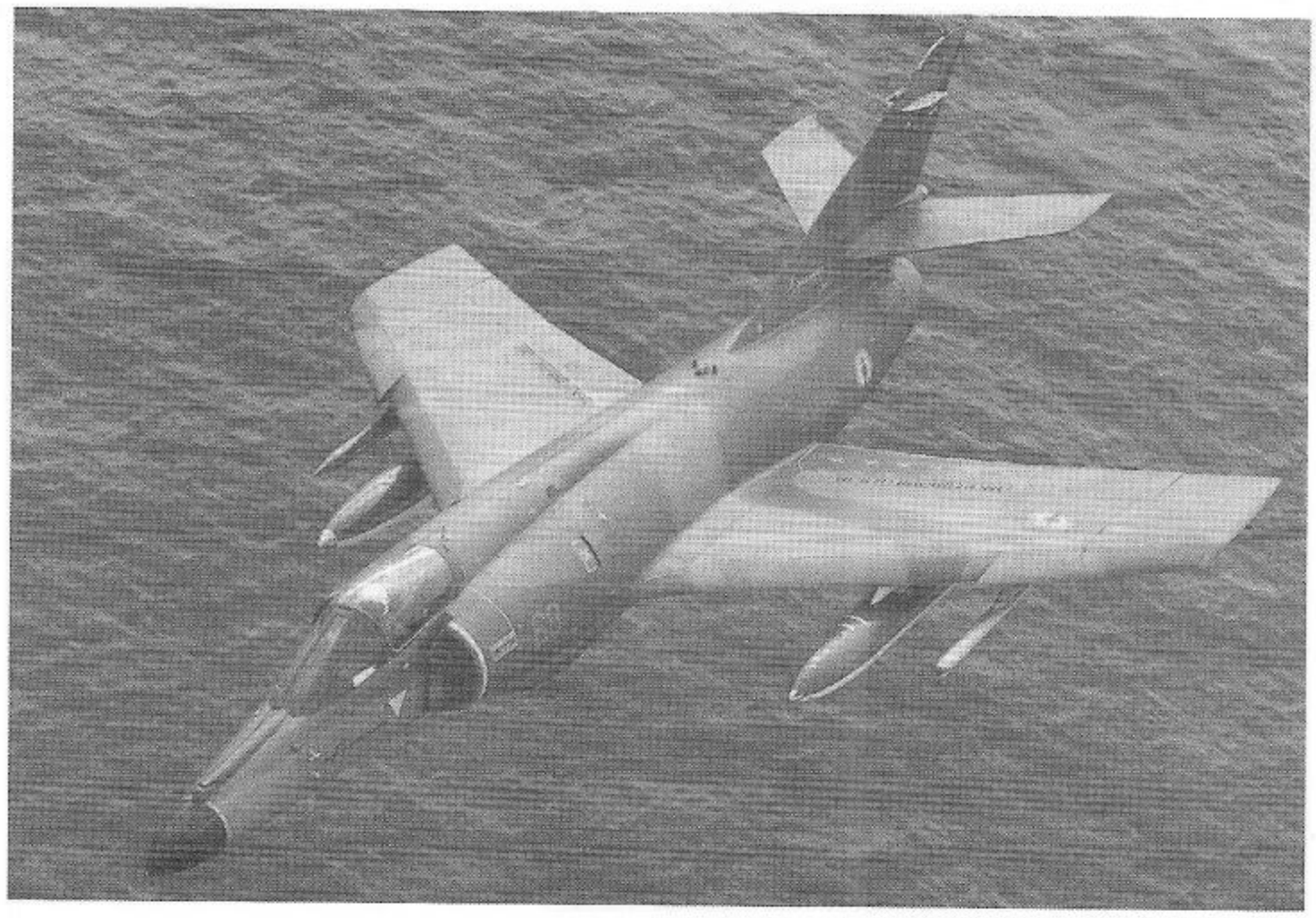
PROGRAMME

The Aeronavale's Etendard IV-M entered service in 1962 and the initial plan to replace it was to use a navalised version of the SEPECAT Jaguar. When that aircraft was cancelled, however, it was decided to develop a much improved version of the Etendard, to be known as the Super Etendard. Although bearing some outward resemblance — and, in theory supposedly possessing 90 per cent commonality — to its predecessor, the Super Etendard was, in fact, virtually a new aircraft, with its airframe redesigned for higher speeds and a new, more powerful and more efficient engine. A new multimode radar was designed for the low-level attack role to enable the aircraft to launch the AM.39 Exocet anti-ship missile and the aircraft was also fitted to carry the French ANT-52 nuclear weapon.

It was planned to order 100, but this was reduced to 71 for budgetary reasons. The first true prototype flew in November 1977 and deliveries started in June 1978.

FURTHER INFORMATION

Argentine Navy Super Etendard; a further aircraft was lost in 1996 reducing the total remaining to 10 (Dassault)



Super Etendard Modernisé (Aviaplans/F Robineau)

The Super Etendard started to replace the Etendard IV-M (but not the photoreconnaissance Etendard IVP) from 1979 onwards.

NAVAL OPERATORS

Argentina: The only export order was for 14 standard Super Etendards for the Argentine Navy of which 10 remain. These were ordered in order to operate from the carrier *Veinticinco de Mayo,* but despite strenuous efforts this proved impossible and the Argentine aircraft have always operated from land bases. Five of the aircraft were received in time for the Falklands (Malvinas) war and, using AM38 Exocet missiles, they were responsible for sinking the British destroyer HMS *Sheffield* (4 May 1982) followed by the large supply ship *Atlantic Conveyor* on 25 May.

France: The French Navy received 71 aircraft of which some 55 survive. All operational aircraft serve with either 11 F at Landivisiau or 17 F at Hyeres, which have 20 aircraft each. The air wings aboard the carriers *Foch* and *Clemenceau* include 18 Super Etendards each.

Iraq: The French Government authorised the lease of five navy Super Etendards to the Iraqi Air Force in October 1983. Using AM39 Exocets which had been sold to Iraq, the Super Etendards sank numerous Iranian tankers. Four aircraft were subsequently returned in early 1985.

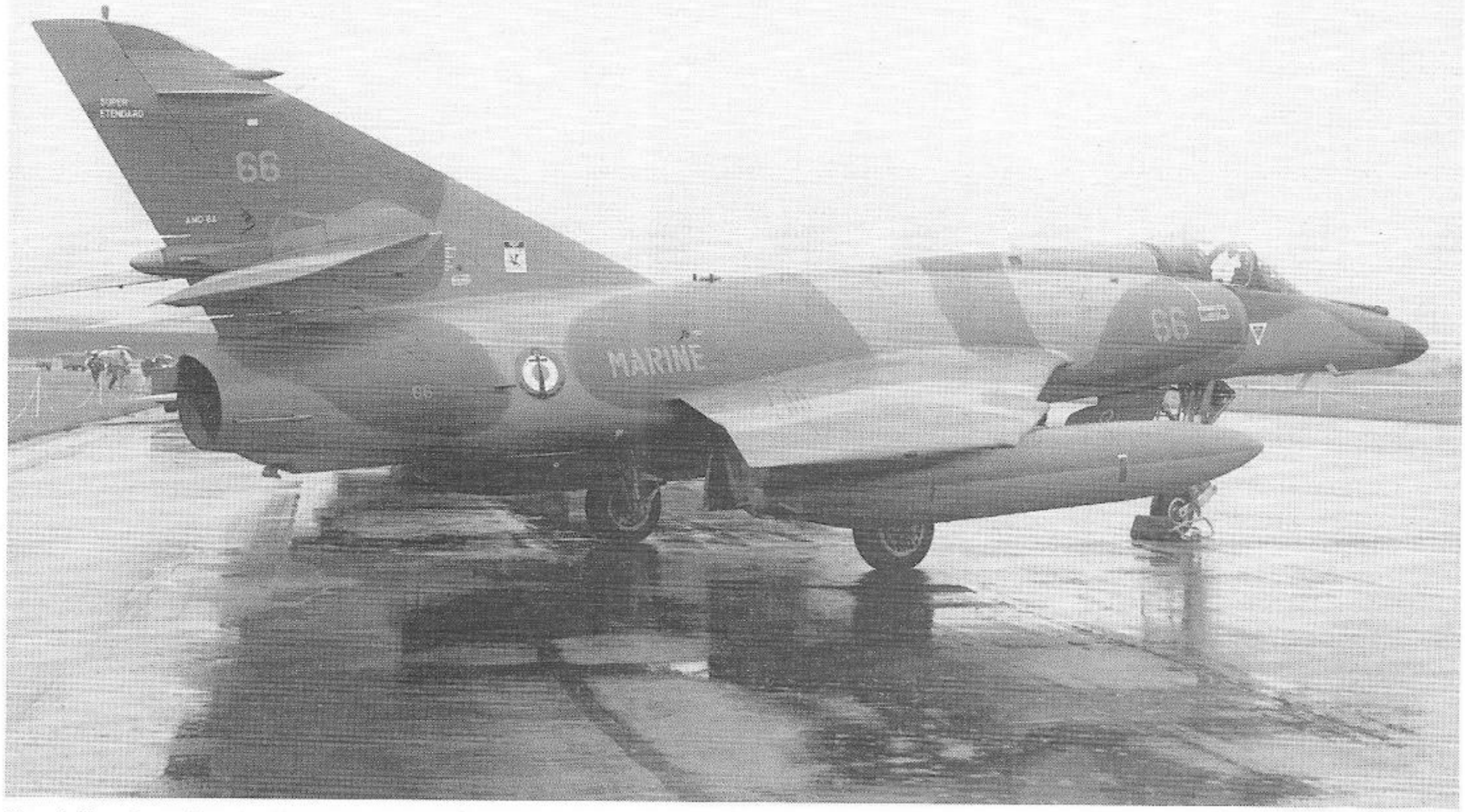
DESIGN

In the event, the Super Etendard had less than 10 per cent commonality with its predecessor. The Atar 8K-50 is a non-afterburning version of the Mirage F1's Atar 8K-50, giving the Super Etendard a lower specific fuel consumption and 10 per cent more thrust than the Etendard IV-M. The Super Etendard is fitted for in-flight refuelling and can also carry a 'buddy pack' to refuel other aircraft.

MODERNISATION

All surviving French aircraft are being upgraded to Super Etendard Modernisé standard. This involves replacement of the original Agave radar by the Dassault Electronique Anémone, which has twice the detection range against surface targets, a new SAGEM inertial navigation system, UAT 90 computer; Thomson-CSGF wide-angle head-up display (HUD) with TV or IR overlay, HOTAS controls and provision for pilot's night vision goggles. The airframe is also upgraded to give the additional 6,500 hours' life needed to enable the aircraft to survive until replaced by Rafale Ms in about 2005.

An additional modification will be the addition of new air-to-surface capabilities, including the ability to carry and launch laser-guided weapons.



French Navy Super Etendard (Jane's/Paul Tompkins)

DASSAULT RAFALE M

AIRCRAFT

Role: Single-seat Avion de Combat Marine (French Navy) interceptor, multirole fighter and reconnaissance aircraft

In naval service: France (requirement is for 86)

SPECIFICATIONS

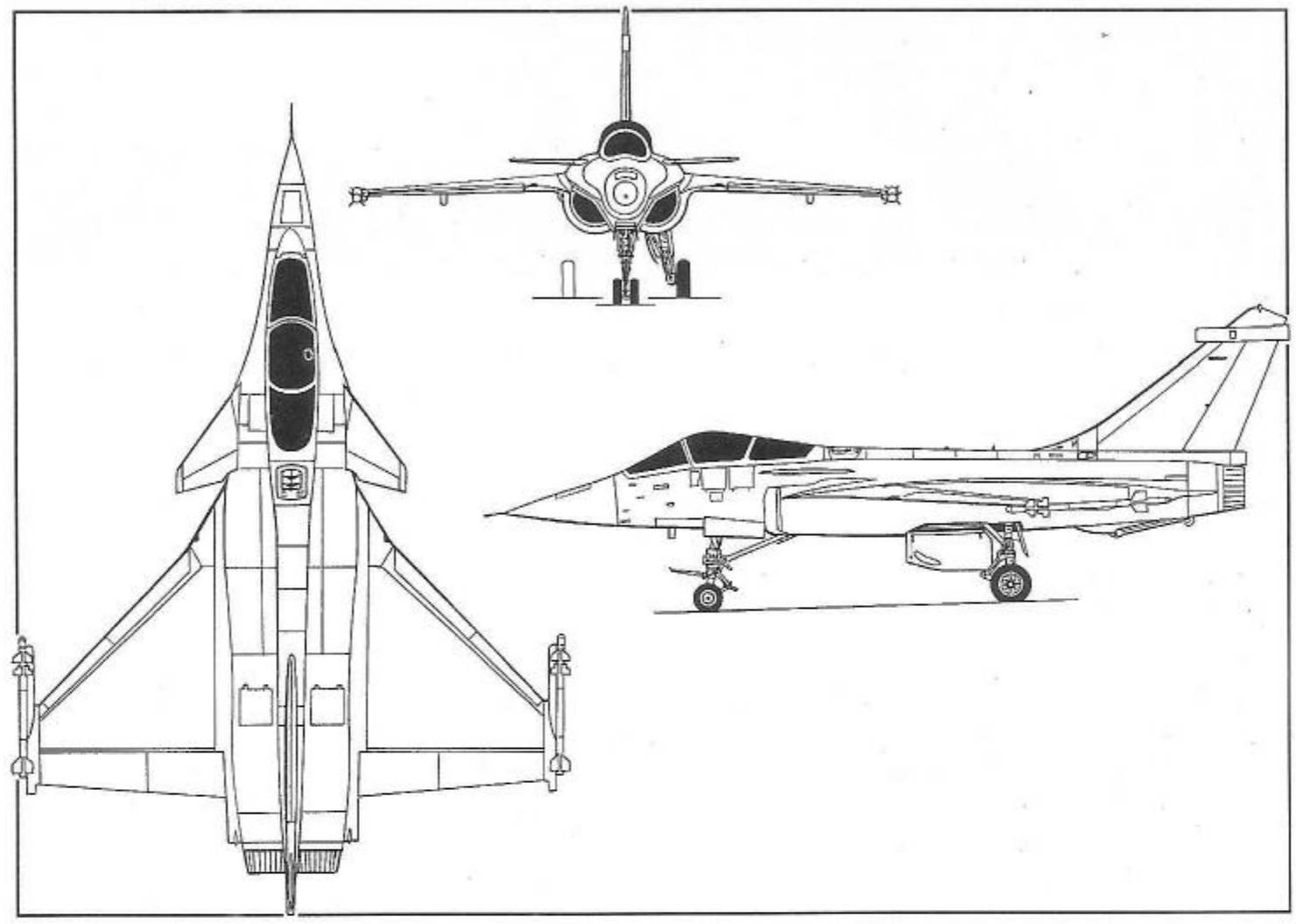
Dimensions
Wing span (incuding wingtip missiles): 10.90 m (35.77 ft)
Length overall: 15.30 m (50.20 ft)
Height overall (Rafale D): 5.34 m (17.5 ft)
Gross wing area: 46.00 m² (495.1 sq ft)

Weights
Basic weight empty, equipped: 9,670 kg (21,319 lb)
External load:
normal: 6,000 kg (13,228 lb)
max: 8,000 kg (17,637 lb)
Max take-off weight:
initial version: 19,500 kg (42,990 lb)
developed version: 21,500 kg (47,399 lb)
aboard aircraft carrier *Foch*: 16,500 kg (36,376 lb)

Performance (estimated)
Max level speed:
at altitude: Mach 2
at low level: 750 kts (1,390 km/h)
Approach speed: 115 kts (213 km/h)
Radius of action: Low-level penetration with 12 × 250 kg bombs, 4 Mica AAMs and 4,300 litres (1,135 US gallons; 946 Imp gallons) of external fuel in 3 tanks — 590 n miles (1,093 km); air-to-air, long range with 8 Mica AAMs and 6,600 litres (1,742 US gallons) of external fuel in 4 tanks, 12,200 m (40,000 ft) transit — 1,000 n miles (1,852 km)

Accommodation: Pilot only, on Hispano-Suiza licence-built Martin-Baker Mk 16 zero/zero ejection seat, reclined at angle of 29°
Power plant: 2 SNECMA M88-2 augmented turbofans, each rated at 48.7 kN (10,950 lb st) dry and 72.9 kN (16,400 lb st) with afterburning. M88-3 of 87 kN (19,558 lb st) max rating in production aircraft
Avionics: (Provision for more than 780 kg (1,720 lb) of avionics equipment and racks)
Communications: EAS V/UHF and TRT Saturn UHF radios. TEAM intercom; Sextant Avionique voice activated radio controls and voice alarm warning system. Thomson-CSF/CNI IFF. Chelton aerials
Radar: GIE Radar (Thomson-CSF/Dassault Electronique) RBE2 look-down/shoot-down radar, able to track up to eight targets simultaneously, with automatic threat assessment and allocation of priority
Flight: SOCRAT VOR/ILS; SAGEM Sigma RL90 INS (interface with carrier's navigation on Rafale M); Sigma RL-90 ring-laser gyro INS; Thomson-CSF/CNI radio altimeter and SFIM/Dassault Electronique flight recorder. Sextant Avionique GPS
Mission: Thomson-TRT/SAT OSF electro-optical sensors. Communications via SINTAC/JTIDS. Various reconnaissance, ECM, FLIR and laser designation pods
Self-defence: Spectra radar warning and ECM suite by Thomson-CSF, Dassault Electronique and Matra.

Weapons
Nuclear: 1 Aerospatiale ASMP standoff nuclear weapon
Interception role: Up to 8 Mica AAMs (with IR or active homing) and 2 underwing fuel tanks; or 6 Micas and 5,700 litres (1,505 US gallons) of external fuel
Air-to-ground role: Typically 16—227 kg (500 lb) bombs, 2 Micas and 2—1,300 litres (343 US gallon) tanks; or 2 Apache standoff weapon dispensers, 2 Micas and 5,700 litres of external fuel; or FLIR pod, Atlis laser designator pod, 2—1,000 kg (2,205 lb) laser-guided bombs, 2 AS.30L laser ASMs, 4 Micas and single 1,700 litres (449 US gallon) tank



Dassault Rafale M (Jane's/Dennis Punnett)

Rafale M01 lands during first carrier trial in April 1993 (Dassault/Aviaplans)

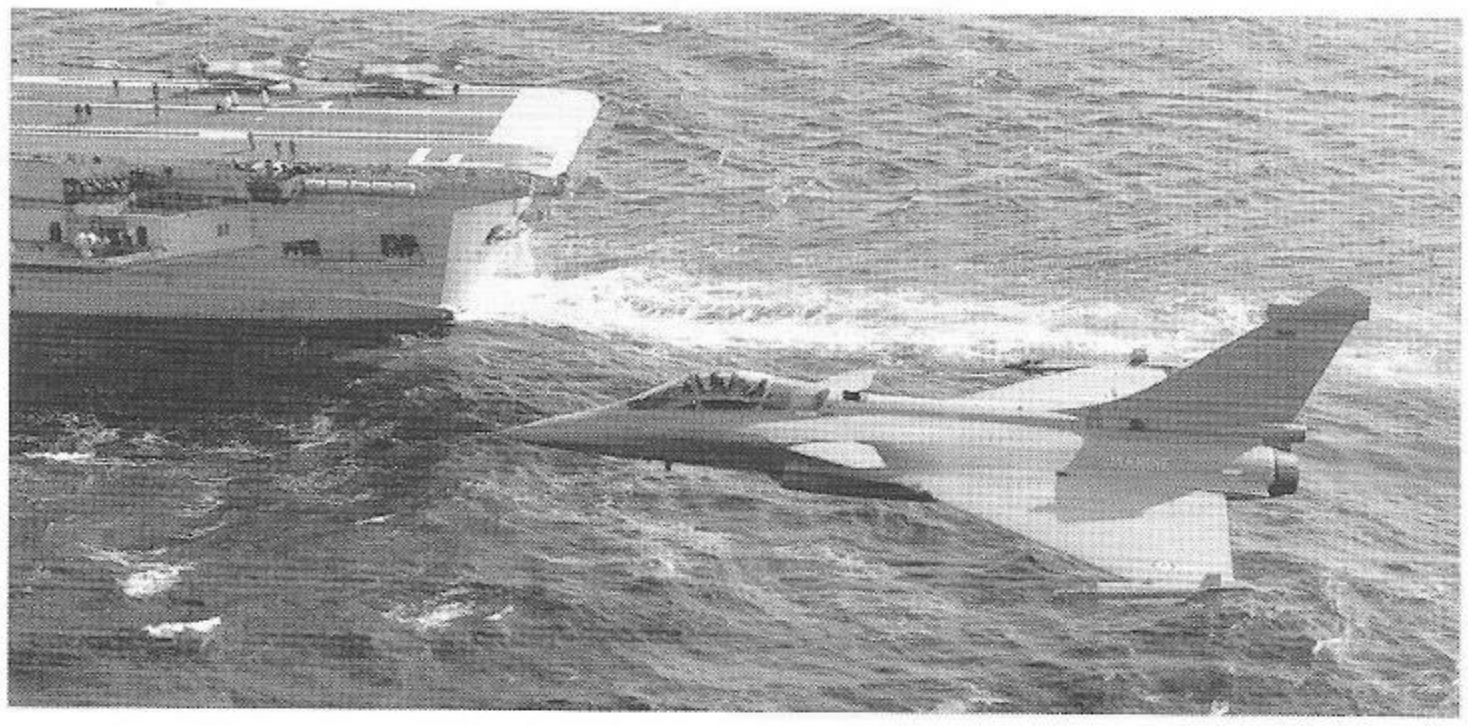
Anti-ship role: 2 Exocet or (projected) ANS sea-skimming missiles, 4 Micas and 4,300 litres (1,135 US gallons) of external fuel
Gun: 1—30 mm Giat DEFA 791B cannon is permanently installed in side of port engine duct

Weapon stations: 14 Alkan external stores attachments: 2 on fuselage centreline, 2 beneath engine intakes, 2 astride rear fuselage, 6 under wings and 2 at wingtips. Forward centreline position deleted on Rafale M

FURTHER INFORMATION

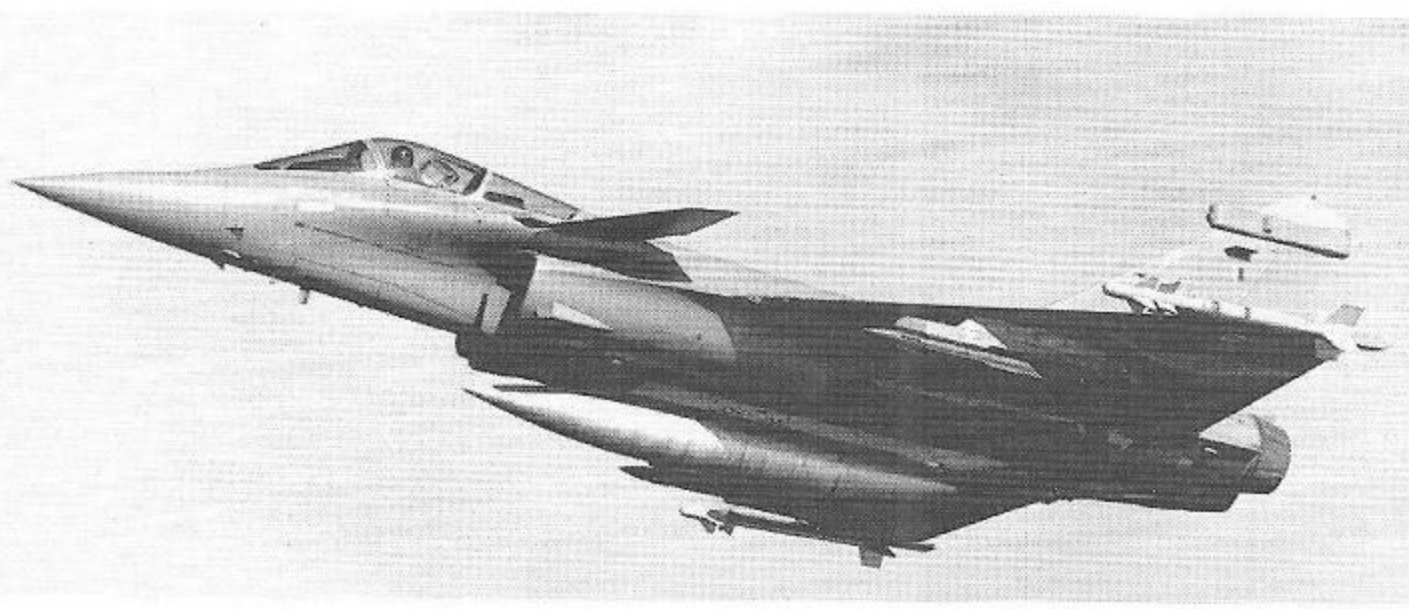
PROGRAMME

The Rafale is a joint air force/navy programme for a multipurpose combat aircraft for the 21st century. The naval version, originally known as the Avion de Combat Marine (ACM), has been ordered to replace the navy's ageing Crusaders and Super Etendards. Indeed, so urgent is the need to replace the Crusaders that it has been decided to accelerate the programme by accepting early Rafales to SU0 interceptor standard, which means that they will lack ASMP, helmet-mounted sight, OSF and voice-command controls. The definitive SU1 attack version will then be delivered between 2005 and 2009, finally replacing the Super Etendards.



Rafale M prototype overflies the carrier Foch *and two of the Super Etendards it will eventually replace* (Dassault/Aviaplans)

Rafale M01 at start of take-off run for first carrier take-off. Note the small ski ramp at the forward end of the run (Dassault/Aviaplans)



Rafale M with a full range of missiles on the underwing and wingtip weapon stations (Dassault/Aviaplans)

The Rafale M is the single-seat carrierborne fighter element of the programme, the 'navalisation' weight penalty being 610 kg (1,345 lb). The Rafale M has 80 per cent structural and equipment commonality with Rafale C and 95 per cent systems commonality. One problem of operating the aircraft from the *Foch* is that take-off weight will be limited to 16,500 kg (36,376 lb). The navy's financial share of the programme was cut in 1991 from 25 to 20 per cent.

The first flight of the Rafale A prototype took place in July 1986 and M01, the first navalised prototype, was ordered in December 1988 and first flew in December 1991. Since then it has undergone three series of catapult trials at shore facilities in the USA: in July/August 1992, January/February 1993 and November/December 1993. Deck trials have also taken place aboard the carrier *Foch,* with the first actual landing taking place on 19 April 1993, followed by the first deck launch the next day. The first take-offs using 'jump strut' nosewheel leg did not, however, take place until the following month.

M02, the second naval prototype, first flew in November 1993 and joined M01 for the carrier trials aboard *Foch* in January/February 1994, and later undertook a further series of trials on its own in October/November 1994, involving 28 launches, two of them at night. M02's trials have included maintenance, electromagnetic compatibility, RBE2 radar and Spectra ECM tests.

Associated programmes include Thomson-CSF/Dassault Electronique electronic scanning RBE2 *(Radar a Bayalage Electronique deux plans)* multimode radar, which was ordered in November 1989, with test flights beginning in a Falcon 20 in July 1992. Five Falcon 20s and four Mirage 2000s have been involved in these RBE2 trials, plus the final three Rafale prototypes. The Dassault Electronique/Thomson-CSF/Matra defensive aids package is named Spectra *(Système pour la Protection Electronique Contre Tous les Rayonnements Adverses)*, which gives wholly internal IR detection, laser warning, electromagnetic detection, missile approach warning, jamming and chaff/flare launching. Nine prototype systems have been ordered, with trials starting in a Mirage 2000 in 1992. Development contract was also awarded in 1991 for Thomson-TRT/SAT OSF *(Optronique Secteur Frontal)* with IRST, FLIR and laser rangefinder in two modules ahead of the windscreen: surveillance, tracking and lock on are carried out by the port module; and target identification, analysis and optical identification by the starboard module. Their outputs are combined and displayed in the pilot's head-level display unit. This system will be installed in the 41st and subsequent Rafales. The DEFA 791 gun and Magic 2 AAMs were first fired from Rafales on 5 March and 26 March 1993, respectively.

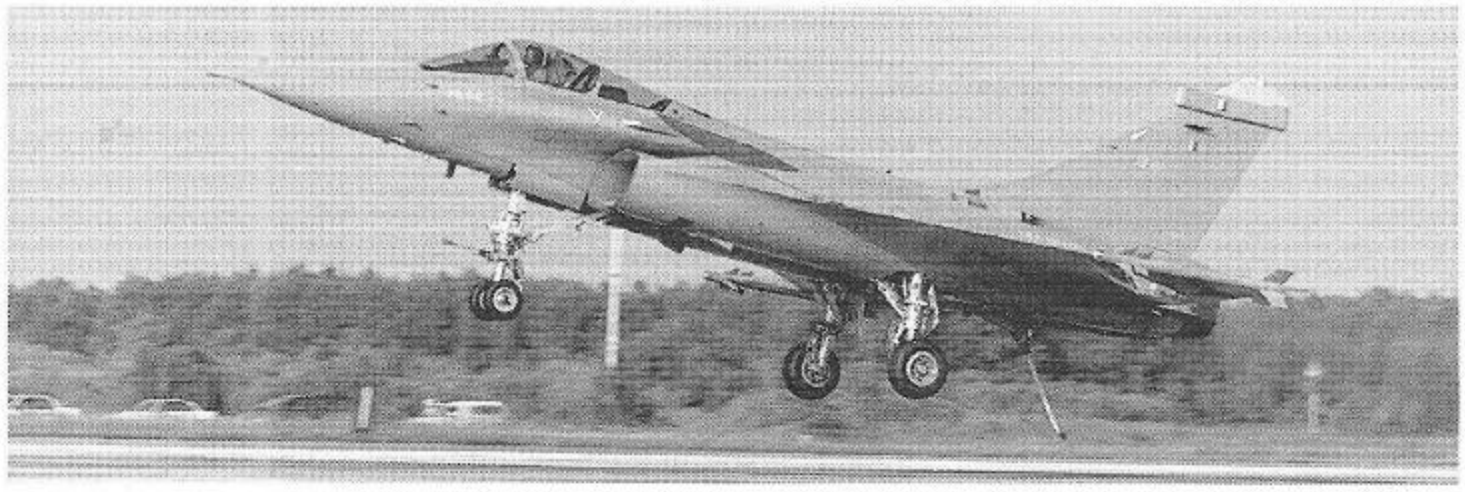
COSTS

The overall costs of the Rafale programme were estimated in 1991 to be some FFr155 billion, which was raised to FFr178 billion in 1993 and to FFr198.4 billion in 1995. These estimates included research and development, industrialisation and the production of 320 aircraft. The naval share of the programme is FFr48.71 billion at 1994 prices and it should be noted that this is quite separate from the costs of the *Charles De Gaulle* aircraft carrier programme.

DESIGN

The design represents the minimum weight and volume structure to meet the operational requirement and thus hold costs to the minimum. The aircraft has a thin, mid-mounted delta wing with a moving canard, and is fully fly-by-wire. Extensive use is made of lightweight materials, with carbonfibre being used for most of the wing components, including the elevons, 50 per cent of the fuselage, wheel and engine doors and the fin. The slats are made of titanium, the wingroot and tip fairings of Kevlar, while the canard is fabricated mainly by superplastic forming and diffusion bonding, the fuselage side skins are made of aluminium-lithium alloy.

The Messier-Dowty hydraulically retractable tricycle landing gear has single mainwheels and twin, hydraulically steerable, nosewheels, all of which retract forward. The system is designed for impact at vertical speed of 6.5 m (21 ft)/s without flare-out. Rafale M has a special 'jump strut' nosewheel leg which releases energy stored in the shock-absorber at the end of deck take-off run, which changes the aircraft's attitude for climb-out without requiring a ski ramp. This 'jump strut' is claimed to give an advantage equivalent to 9 kts (16 km/h) in speed or 900 kg (1,984 lb) extra weapon load. This device cannot, however, be used aboard the carrier *Foch,* which will have 1° 30′ ramp giving 20 knots (37 km/h) or 2,000 kg (4,409 lb) advantage, instead.



Rafale M prototype undergoing carrier landing and take-off tests at the US Navy's Lakehurst facility (Dassault/F Robineau)

MCDONNELL DOUGLAS/BRITISH AEROSPACE AV-8B HARRIER II and AV-8B HARRIER II PLUS

AIRCRAFT

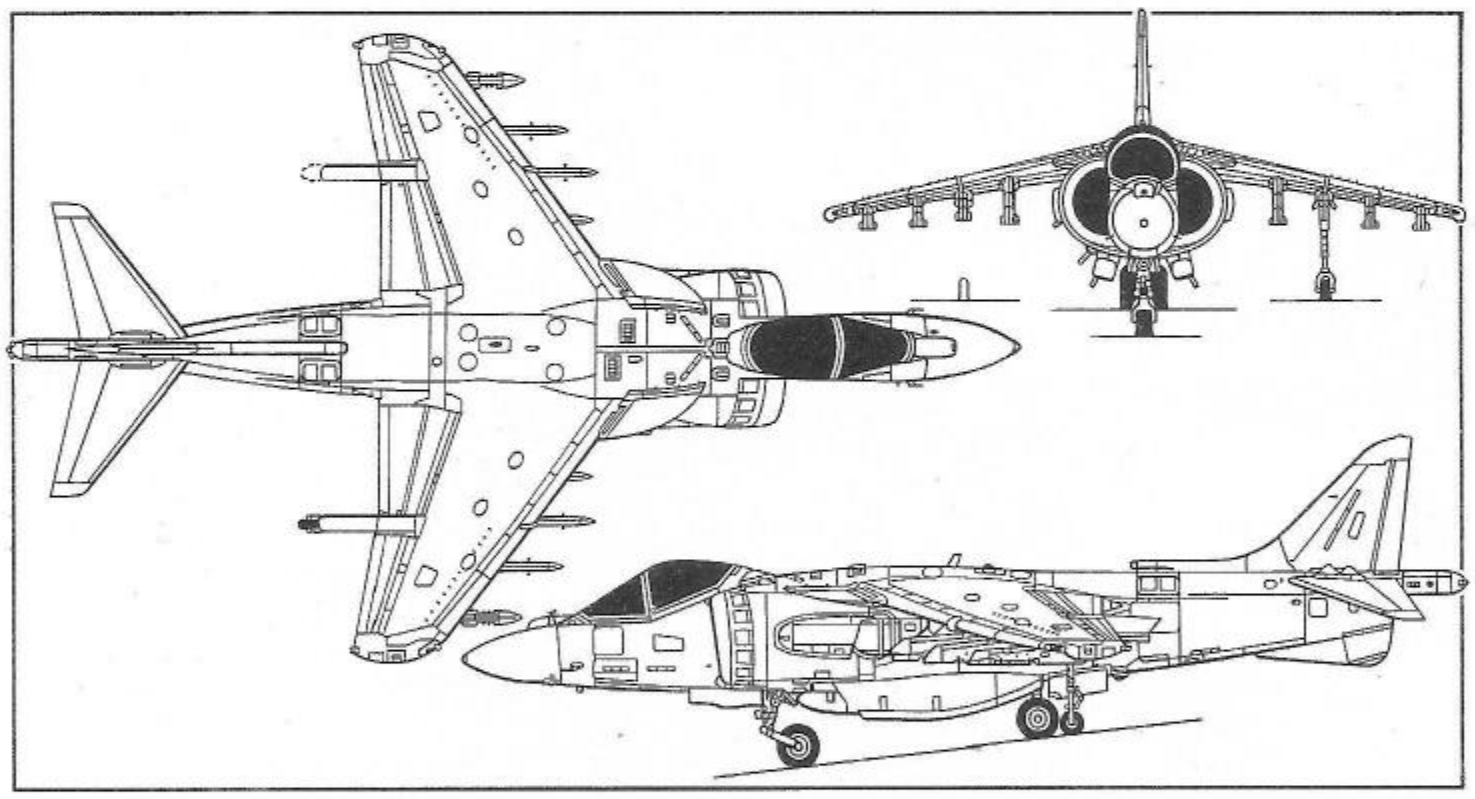
Role: Single-seat V/STOL close support, battlefield interdiction, night attack and reconnaissance aircraft

In naval service: Italy (16 (plus 2 TAV-8B)); Spain (7, plus 2 TAV-8B)); USA (179, plus 24 TAV-8B))

SPECIFICATIONS

(AV-8B Harrier II)
Dimensions
Wing span: 9.25 m (30.33 ft)
Length overall (flying attitude):
AV-8B: 14.12 m (46.33 ft)
TAV-8B: 15.32 m (50.25 ft)
Height overall: 3.55 m (11.64 ft)
Outrigger wheel track: 5.18 m (17.0 ft)
Gross wings area, excluding LERX: 21.37 m² (230.0 sq ft)
LERX area (total):
Pegasus 11-21: 0.81 m² (8.7 sq ft)
Pegasus 11-61: 1.24 m² (13.4 sq ft)
'100 per cent': 1.39 m² (15.0 sq ft)

Weights (single-seaters, except where indicated)
Operating, empty (including pilot, fuel):
AV-8B: 6,336 kg (13,968 lb)
TAV-8B: 6,451 kg (14,223 lb)
Max fuel, internal:
AV-8B: 3,519 kg (7,759 lb)
TAV-8B: 3,269 kg (7,306 lb)
Max fuel, internal and external:
AV-8B: 7,180 kg (15,829 lb)
TAV-8B: 6,930 kg (15,376 lb)
Max external stores:
Pegasus 11-61: 6,003 kg (13,235 lb)
Pegasus 11-21/Mk 105: 4,899 kg (10,800 lb)

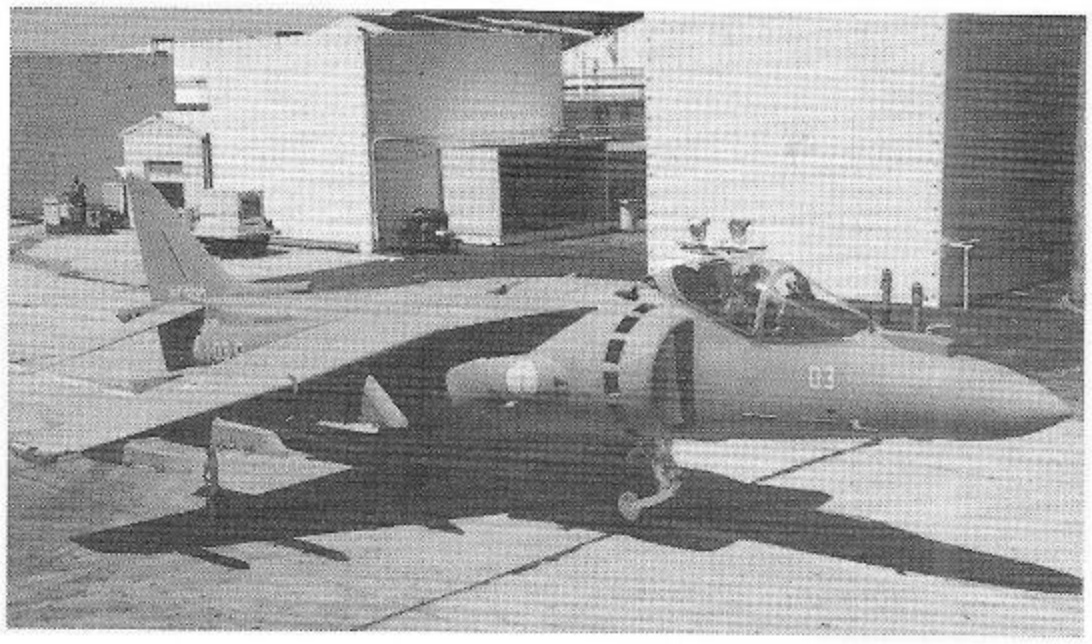


McDonnell Douglas/BAe Harrier II Plus (Jane's/Mike Keep)

Max useful load (including fuel, stores, weapons, ammunition, and water injection for engine):
VTO: Approx 3,062 kg (6,750 lb)
STO: More than 7,710 kg (17,000 lb)

Basic flight design gross weight for 7 *g* operation: 10,410 kg (22,950 lb)
Max take-off weight:
STO (435 m (1,427 ft) run): 14,061 kg (31,000 lb)

The second two-seat TAV-8B for the Italian Navy (Jane's/Paul Tompkins)



The first single-seat AV-8B Plus for the Italian Navy, delivered in April 1994 (Jane's)

US Marine Corps AV-8B Harrier II (McDonnell Douglas)

VTO (sea level, ISA) (AV-8B with Pegasus 11-61 engine): 9,342 kg (20,595 lb)
VTO (sea level, 32°C): 8,142 kg (17,950 lb)
Design max landing weight: 11,340 kg (25,000 lb)
Max vertical landing weight: 9,043 kg (19,937 lb)

Performance
Max speed in level flight:
at sea level: Mach 0.87 (575 kts; 1,065 km/h)
at altitude: Mach 0.98
STOL take-off run at max take-off weight:
ISA: 435 m (1,427 ft)
32°C: 518 m (1,700 ft)
Operational radius with external loads shown:
short take-off (366 m; 1,200 ft), 12 Mk 82 Snakeye bombs, internal fuel, 1 h loiter: 90 n miles (167 km)
hi-lo-hi, short take-off (366 m; 1,200 ft), 7 Mk 82 Snakeye bombs, 2—300 US gallon external fuel tanks, no loiter: 594 n miles (1,101 km)
deck launch intercept mission, 2 AIM-9 missiles and 2 external fuel tanks: 627 n miles (1,162 km)
Unrefuelled ferry range, with 4—300 US gallon external tanks:
tanks retained: 1,638 n miles (3,035 km)
tanks dropped: 1,965 n miles (3,641 km)
Combat air patrol endurance at 100 n miles (185 km; 115 miles) from base: 3 hours

Accommodation:
AV-8B: Pilot only, on UPC/Stencel zero/zero ejection seat
TAV-8B: Pilot plus co-pilot/trainee pilot on UPC/Stencel zero/zero ejection seats

Power plant
USMC AV-8B: 1—105.87 kN (23,800 lb st) Rolls-Royce F402-RR-408 (Pegasus 11-61) vectored thrust turbofan in AV-8B (95.42 kN; 21,450 lb st) F402-RR-406A/Pegasus 11-21 in aircraft delivered before December 1990)
Spanish Navy AV-8B: Rolls-Royce Pegasus Mk 152-42
Italian Navy TAV-8B: Rolls-Royce Pegasus F402-RR-408

Avionics
Communications: Collins RT-1250A/ARC-182 U/VHF com; Bendix/King RT-1157/APX-100 IFF
Flight: R-1379B/ARA-63 all-weather landing receiver (AV-8B only), RT-1159A/ARN-118 Tacan, RT-1015A/APN-194(V) radar altimeter, Honeywell CV-3736/A communications/navigation/identification data converter, Litton AN/ASN-130A inertial navigation system,

Spanish Navy EAV-8B Harrier IIs. These will be retrofitted to EAV-8B-plus standard by CASA (Rolls-Royce)

AiResearch CP-1471/A digital air data computer. Flight controls interfacing with reaction control system provided by Honeywell. AN/ASW-46(V)2 stability augmentation and attitude-hold system, now updated to high angle-of-attack capable configuration.
Mission: Primary weapon delivery sensor system is Hughes Aircraft AN/ASB-19(V)2 or (V)3 Angle Rate Bombing Set, mounted in nose and comprising a dual-mode (TV and laser) target seeker/tracker. ARBS functions in conjunction with Unisys CP-1429/AYK-14(V) mission computer, Smiths Industries AN/AYQ-13 stores management system, display computer, HUD and digital display indicator. Night attack versions equipped with GEC-Marconi nose-mounted FLIR. Italian Navy aircraft have Sanders AN/ALQ-164 electronic countermeasures.

Weapons
Guns
Underfuselage gun packs: 2 mounting 5-barrel 25 mm cannon based on General Electric GAU-12/U (port side) and 300 round container (starboard side)
Underwing gun pods: 2 (in addition to underfuselage packs)
Air-to-air missiles: Up to 6 AIM-9L Sidewinder, Magic, or AGM-65E Maverick
Air-to-ground gravity weapons: Up to 16—540 lb free-fall or retarded general purpose bombs; 12 BL755 or similar cluster bombs, 1,000 lb free-fall or retarded bombs; 10 Paveway laser-guided bombs; 8 fire bombs
Air-to-ground rockets: 10 Matra 155 rocket pods (each with 18—68 mm SNEB rockets)
Weapons stations: Single 454 kg (1,000 lb) stores mount on fuselage centreline, between gun packs. Three stores stations under each wing on AV-8B, stressed for loads of up to 907 kg (2,000 lb) inboard, 454 kg (1,000 lb) on intermediate stations, and 286 kg (630 lb) outboard. Four inner wing stations are wet, permitting carriage of auxiliary fuel tanks; reduced manoeuvring limits apply when tanks mounted on intermediate stations. ML Aviation BRU-36/A bomb release units standard on all versions.
TAV-8B: 6 Mk 76 practice bombs or 2 LAU-68 rocket launchers for weapons training.

FURTHER INFORMATION

PROGRAMME

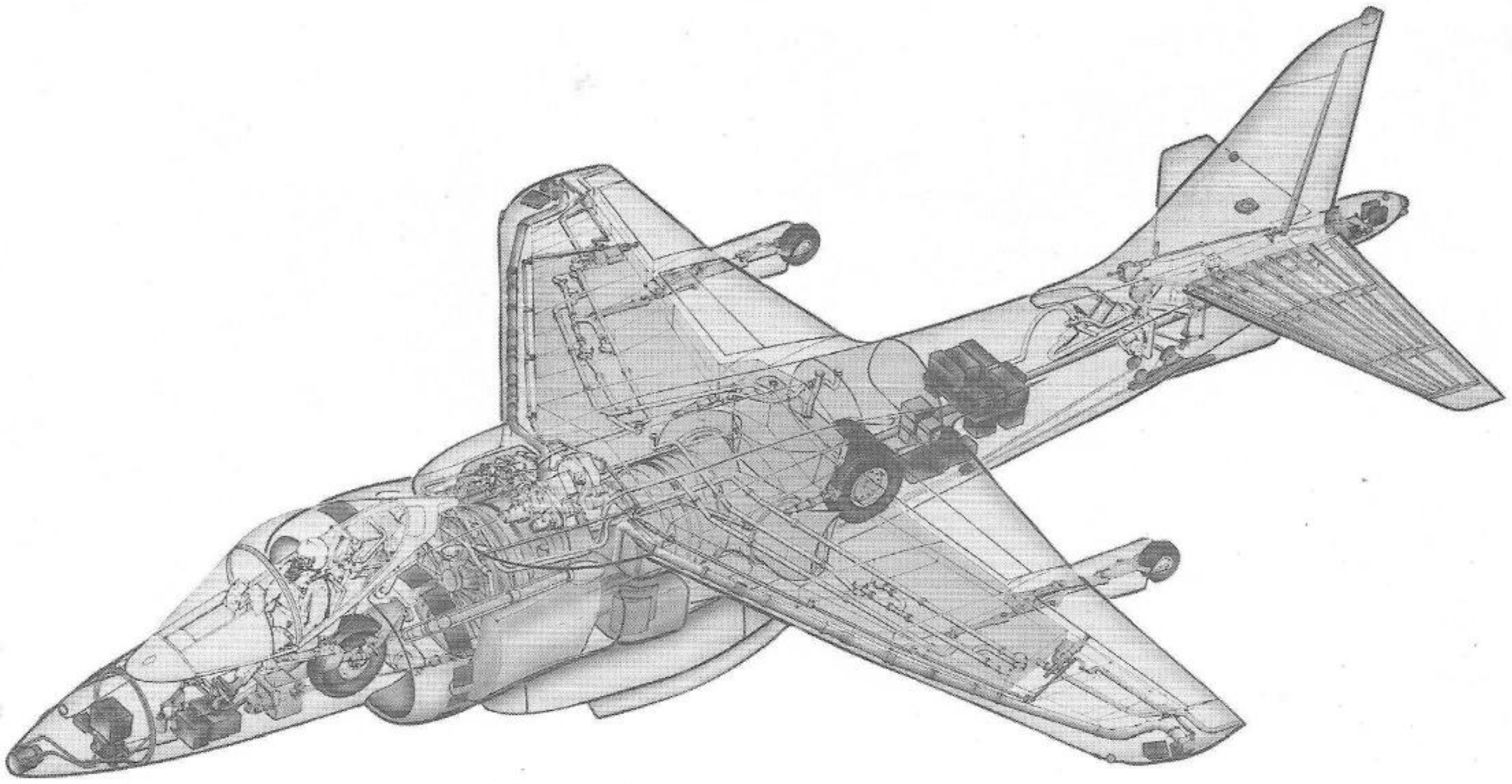
Whereas British Aerospace led the manufacturing grouping for the AV-8A Harrier, in the second-generation AV-8B Harrier II McDonnell Douglas became the leader. The new design incorporated a supercritical wing, carbon fibre composites and many other detailed changes, which resulted in a virtually new aircraft. Two converted AV-8As (designated YAV-8B) served as aerodynamic prototypes, the first flying in November 1978. These were followed by four full-scale development aircraft, with the first deliveries being made to the USMC on 12 January 1984 and the first squadron attaining IOC in August 1985.

The first flight of the two-seat TAV-8B took place on 21 October 1986, with deliveries beginning in August 1987. This two-seat operational trainer has a longer forward fuselage and 0.43 m (1 ft 5 in) taller vertical tail than AV-8B, and there are only two underwing weapon stations.

Next version for the USMC was the AV-8B Night Attack version which has a FLIR (forward-looking infra-red) bulge ahead of the windscreen. The 167th AV-8B and onwards were produced to his standard.

The original power plant was the Rolls-Royce F402-RR-406A Pegasus (95.42 kN; 21,450 lb st) but from the 182nd AV-8B and 16th TAV-8B onwards this was replaced by the Rolls-Royce F402-RR-408 (105.87 kN (23,800 lb st).

The Spanish programme
Having gained considerable experience with the original AV-8A, the Spanish Navy placed an early order for



Cutaway of AV-8B Plus, showing radar and other installations (McDonnell Douglas/BAe)

the AV-8B Harrier II and took delivery of 12 for Novena Escuadrilla (9 Squadron) between October 1987 and September 1988. These are designated VA.2 Matador II in Spanish service, but have the manufacturers' designation EAV-8B. Of those 12, 10 survive in 1996 and these are all due to be converted to Harrier II Plus standard by CASA. In addition, eight new-build Harrier II Plus have been ordered, for which first rear fuselage was delivered to CASA in December 1994 to launch local assembly.

The Italian programme

As described in the *Giuseppe Garibaldi* entry, the Italian Navy had to overcome a major legal problem before it was able to place an order for fixed-wing aircraft for its new carrier. The order was, however, eventually placed in May 1989 and two TAV-8Bs were delivered in August 1991. The Italian Navy has ordered a total of 18 aircraft: two TAV-8Bs and 16 Harrier II Plus, with an option on a further eight. The first delivery of the two TAV-8Bs was made on 23 August 1991.

Spanish AV-8B air-to-air refuelling (McDonnell Douglas)

DESIGN

Compared to the AV-8A, the AV-8B has a bigger wing and longer fuselage and makes wide-scale use of graphite epoxy (carbon fibre) composite materials for the wings, parts of the fuselage and the tail unit. A supercritical wing section has been adopted and there are additional lift devices. The forward fuselage, cockpit and engine air intakes have been redesigned and there are two additional wing stores stations, while the wing outriggers have been relocated at mid-span to provide better ground manoeuvring capability. New leading-edge root extensions (LERX) enhance instantaneous turn rate and air-combat capability. The landing gear has been strengthened to cater for higher operating weights and greater external stores loads. Wing span and area have been increased by approximately 20 per cent and 14.5 per cent respectively compared with the AV-8A and leading-edge sweep has been reduced by 10°.

SUKHOI SU-33 (NATO = FLANKER-D)

AIRCRAFT

In naval service: Single-seat ship-based air defence fighter

In naval service: Russia (20 (estimated))

SPECIFICATIONS

Dimensions
Wing span: 14.70 m (48.23 ft)
Length overall, incl nose probe: 21.195 m (69.5 ft)
Width, wings folded: 7.40 m (24.28 ft)
Height overall: 5.90 m (19.36 ft)
Tailplane span: 9.90 m (32.5 ft)
Wheel track: 4.40 m (14.44 ft)
Wheelbase: 5.89 m (19.33 ft)
Wings, gross area: 67.80 m² (729.82 sq ft)

Weights
Not available

Performance
Never-exceed speed (VNE) at 11,000 m (36,000 ft): Mach 2.165 (1,240 kts; 2,300 km/h)
Min flying speed: 130 kts (240 km/h)
Take-off run on carrier with 14° ramp: 120 m (395 ft)
Range with max internal fuel: 1,620 n miles (3,000 km)

Power plant: 2 Saturn/Lyulka AL-31F turbofans, each 122.6 kN (27,557 lb st) with afterburning
Fuel: Pressure or gravity fuelling; fuel quantities not known. Retractable flight refuelling probe beneath windscreen on port side; provision for centreline buddy refuelling pack
Accommodation: Pilot only, on Zvezda K-36MD zero/zero ejection seat

Avionics: Systems integrated by NPO Elektro Avtomatika
Radar: Phazotron N001 Zhuk (NATO = Slot Back) track-while-scan coherent pulse Doppler look-down/shoot-down radar (antenna diameter approximately 1.0 m; 3.33 ft) with search range of up to 54 n miles (100 km) against MiG-21 size target (ability to track 10 targets and engage two simultaneously in current Su-27SK)
Navigation: Systems are optimised for use over sea
Instrumentation: Integrated fire-control system enables radar, IRST and laser rangefinder to be slaved to pilot's helmet-mounted target designator and displayed on wide-angle HUD; autopilot able to restore aircraft to right-side-up level flight from any attitude when 'panic button' depressed
Mission: Infra-red search/track (IRST) sensor, range 27 n miles (50 km), and laser rangefinder, range 4.3 n miles (8 km), functioning through common optics in transparent housing forward of windscreen. Provision for reconnaissance pod on centreline pylon
Self-defence: Sirena-3 360° radar warning receivers, outboard of each bottom air intake lip and at tail. Three banks of chaff/flare dispensers in bottom of long tailcone extension

An Su-33 aboard the Kuznetsov. *Note the 135° folding wings and the folding tailplane, the only known example of such a feature*

Armament
One 30 mm GSh-301 gun in starboard wingroot extension, with 150 rounds. Up to 10 air-to-air missiles in air combat role on pylons: two under the fuselage between the engine ducts, one beneath each duct, one under each centre wing and outer wing, and one at each wingtip. Typically, two short-burn semi-active radar homing R-27R (NATO = AA-10A Alamo-A) in tandem under fuselage; two short-burn infra-red homing R-27T (NATO = AA-10B Alamo-B) missiles on centre-wing pylons; and long-burn semi-active radar homing R-27ER (NATO = AA-10C Alamo-C) or infra-red R-27ET (NATO = AA-10D Alamo-D) beneath each engine duct. The four outer pylons carry either R-73A (NATO = AA-11 Archer) or R-60 (NATO = AA-8 Aphid) close-range infra-red missiles. R-33 (NATO = AA-9 Amos) missiles optional in place of AA-10s. Kh-31 (NATO = AS-17 Krypton) air-to-surface missiles can be carried underwing. (The Su-33 has been exhibited with inert 4,500 kg (9,920 lb) Kh-41 (3M80 Moskit (mosquito)) anti-ship missile on centreline, but this is considered an impracticable operational load.)

FURTHER INFORMATION

PROGRAMME

Development work began in the (then) Soviet Union in 1976 aimed at producing a fighter for the planned aircraft carriers. The design is based on the production Sukhoi Su-27, but embodies folding wings, arrester hook and other features required for shipboard operation, together with movable canard foreplanes. A navalised Su-27, fitted with an arrester hook, flew in 1984, followed by the first Su-27K (K = *korabelnyy* (ship-based)) prototype in August 1987. The second Su-27K made the first conventional (that is, non-vertical) landing by a Soviet aircraft on a ship, the *Tbilisi* (later renamed *Kuznetsov*), on 1 November 1989.

Production of the definitive Su-33 began at Komsomolsk-na-Amur in 1990; the first production aircraft flew that year and deliveries began in 1991, with the type reaching IOC (initial operational capability) in 1992. 20 had been delivered and were shore-based on the Kola Peninsula by mid-1994 and undertook five months of intensive flying from *Kuznetsov,* in the Barents Sea, in the second half of 1994. A number were aboard the carrier when it deployed to the Adriatic in January 1996.

An Su-27K exhibits an extraordinary array of weaponry, including the very large Moskit (3M80) anti-ship missile on the centreline pylon (ITAR-TASS)

DESIGN

The airframe is generally similar to the Su-27, but with folding wings and tailplane, added foreplanes, arrester hook under the tailcone and other features necessary for carrierborne operations. The canard foreplanes, which are swept back at 52°, operate at all speeds, and only collectively, not differentially; travel is between 7° up and 70° down. The outer wings fold upwards through 135° and are hydraulically activated, as are the unique upward folding horizontal tail surfaces. The forward landing gear has been strengthened with twin nosewheels, while the long tailcone of land-based versions has been shortened to prevent tailscrapes during take-off and landing aboard the carrier. There is also an IRST with wider angle of view.

BRITISH AEROSPACE VA.1 MATADOR (AV-8S HARRIER)

AIRCRAFT

Role: Single-seat V/STOL close support, battlefield interdiction and reconnaissance aircraft

In naval service: Spain (7 — single-seat; 2 — two-seat) (to be transferred to Thailand)

SPECIFICATIONS

Dimensions
Wing span: 7.70 m (25.25 ft)
Length overall: 13.87 m (45.6 ft)
Height overall: 3.40 m (11.25 ft)
Gross wings area: 18.68 m² (201.1 sq ft)

Weights
Operating, empty (including pilot, fuel): 5,529 kg (12,190 lb)
Max external stores: 5,300 kg (12,404 lb)
Normal take-off weight:
STO: 10,115 kg (22,300 lb)
VTO: 7,734 kg (17,050 lb)

Performance
Max speed in level flight:
at sea level: 640 kts (1,185 km/h)
Service ceiling: 15,240 m (50,000 ft)
Range with max fuel: 1,600 n miles (2,965 km)
Combat radius:
attack: 200 n miles (370 km)
fighter: 400 n miles (740 km)

Accommodation
AV-8S: Pilot only, on Stencel SIII-S3 ejection seat
TAV-8S: Pilot plus co-pilot/trainee pilot on Stencel SIII-S3 ejection seats
Power plant: 1—95.6 kN (21,500 lb st) Rolls-Royce Pegasus 103 vectored thrust turbofan

Post-flight airframe and engine checks are carried out on a Spanish Navy AV-8S Matador at the land base at Rota, near Cadiz (Rolls-Royce)

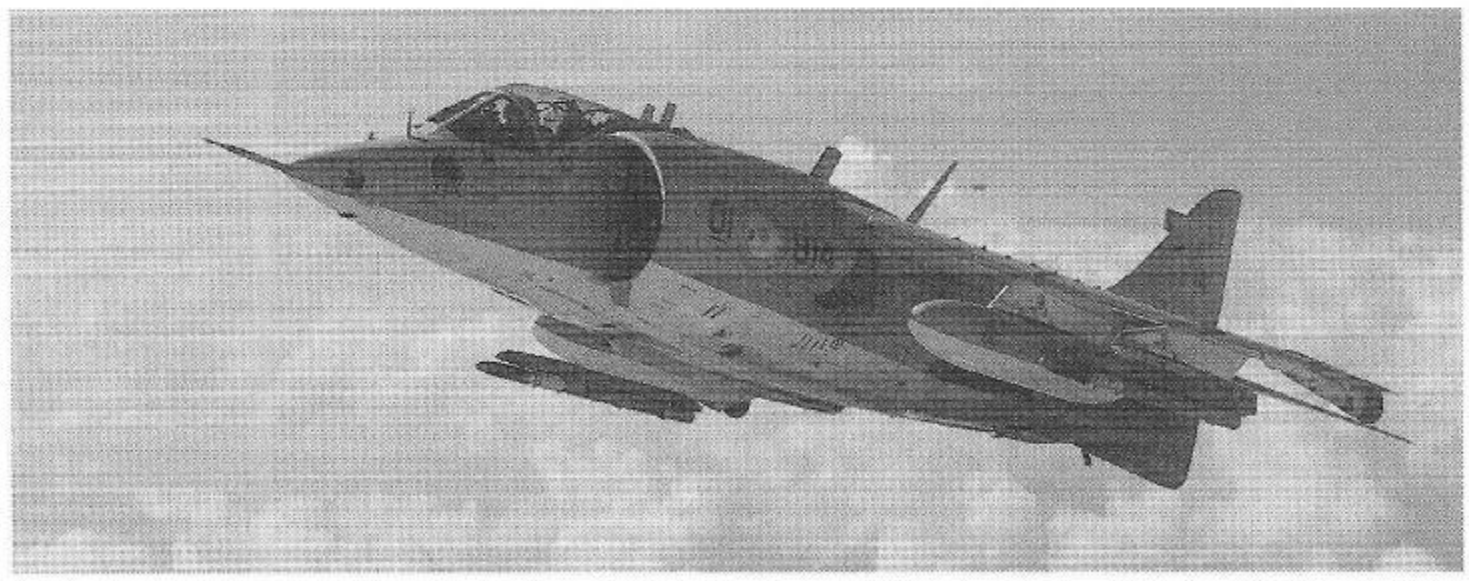
FURTHER INFORMATION

PROGRAMME

The British Aerospace (BAe) Harrier was originally developed for the British Air Force for land-based use, but was evaluated by the US Marine Corps in 1968 for use in amphibious warfare operations. The marines quickly became enthusiastic and placed an order for 114 AV-8As, which was later changed to 102 single-seaters and eight TAV-8A two-seaters. All these were manufactured in the UK by BAe under contract to McDonnell Douglas, but were later upgraded in the USA where they were redesignated AV-8A Mod and TAV-8A Mod, respectively.

The Spanish Navy placed an order for six single-seaters and two-seat trainers in 1975, which were to AV-8A/TAV-8A Mod standard, under the designations VA.1 and VAE.1 Matador, respectively. These were later supplemented by a further five single-seaters, delivered in 1980. These aircraft have been operated by Escuadrilla 8, initially from the carrier *Dedalo* and later from the new *Principe de Asturias.* They are the only versions of the AV-8A remaining in operational service.

Meanwhile, the new aircraft carrier, *Chakri Naruebet,* is being constructed by the Spanish shipyard, Bazan, for delivery to the Thai Navy in 1997. The Thais initially considered the McDonnell Douglas/BAe AV-8B Harrier II for the air wing of this carrier, but later decided on the Spanish AV-8S, which have a considerable residual fatigue life and become available at a reasonable cost when Spain takes delivery of the AV-8B Harrier II Plus. Negotiations dragged on for some time due to the need to seek US authorisation for the deal, but in November 1996 an accord was signed with Spain under which all seven surviving AV-8S and the two TAV-8S will be bought for $90 million and delivered in 1997.



BAe Matador AV-8S; all seven surviving aircraft are to be sold to Thailand for operation aboard the new carrier Chakri Naruebet (BAe)

BRITISH AEROSPACE SEA HARRIER FRS MK 51

AIRCRAFT

Roles: Vertical/short take-off and landing (V/STOL) strike and reconnaissance fighter and (T. Mk 60) two-seater trainer

In naval service: India (23, plus two T Mk 60)

SPECIFICATIONS

Dimensions
Wing span:
normal: 7.70 m (25.25 ft)
ferry: 9.04 m (29.75 ft)
Length:
overall: 14.50 m (47.57 ft)
nose folded: 12.73 m (41.66 ft)
Height overall: 3.71 m (12.17 ft)
Tailplane span: 4.24 m (13.91 ft)
Outrigger wheel track: 6.76 m (22.18 ft)
Wheelbase, nosewheel to mainwheels: Approx 3.45 m (11.33 ft)
Gross wing area: 18.68 m² (201.1 sq ft)

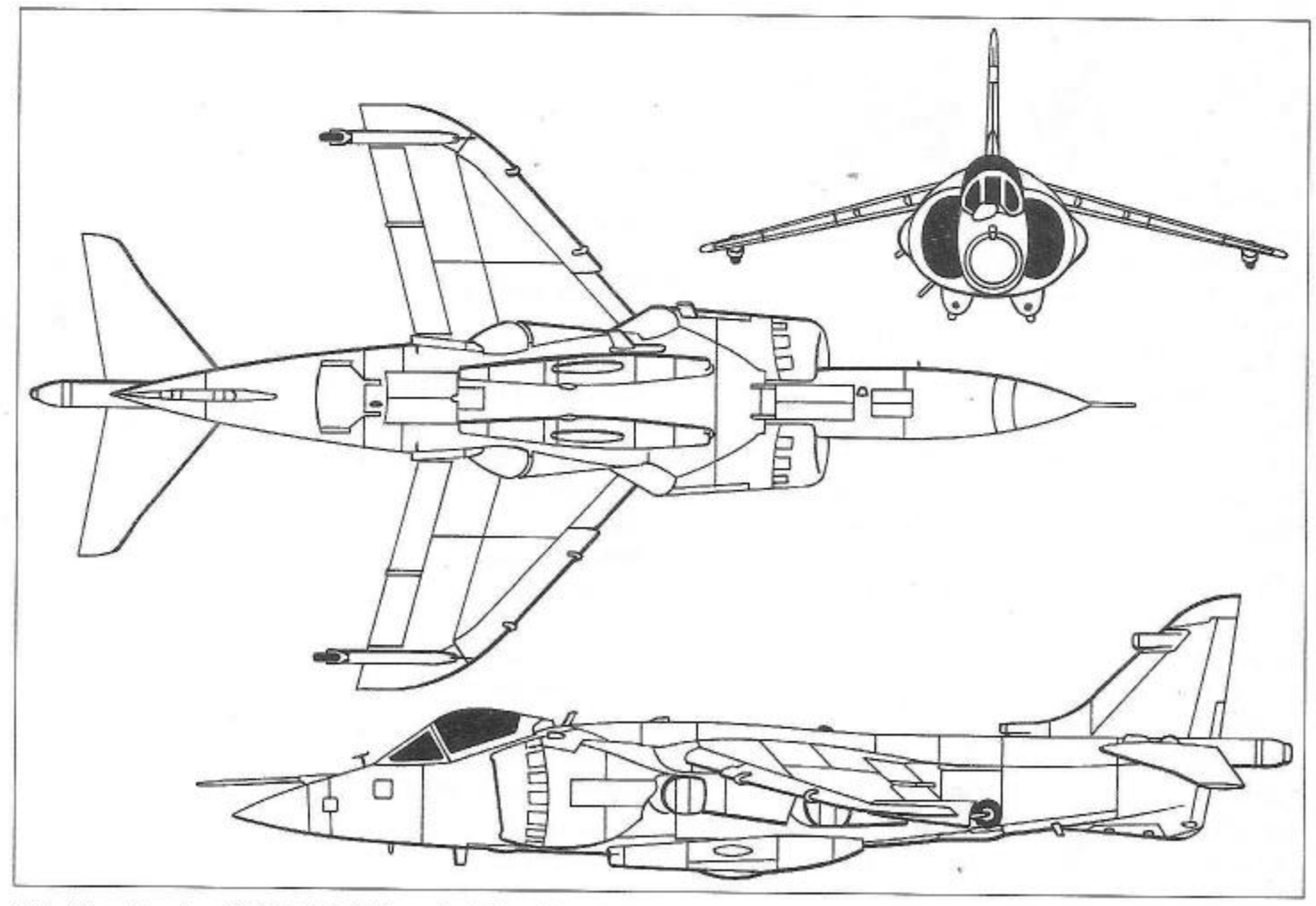
Weights
Operating, empty: 6,374 kg (14,052 lb)
Max fuel:
internal: 2,295 kg (5,060 lb)
external: 2,404 kg (5,300 lb)
Max weapon load:
STO: 3,630 kg (8,000 lb)
VTO: 2,270 kg (5,000 lb)
Max take-off weight: 11,880 kg (26,200 lb)

Performance
Max speed at high altitude: Mach 1.25
Max level speed at low altitude: 640+ kts (1,185+ km/h)
Typical cruising speeds:
high altitude, over 1 h, internal fuel: Mach 0.8+
low altitude: 350-450 kts (650-833 km/h)
STO run, max take-off weight, no ski jump: 305 m (1,000 ft) (approx)
Time from alarm to 30 n miles (55 km): less than 6 min
High-altitude intercept radius, with 3 min combat and reserves for vertical landing: 400 n miles (750 km)
Attack radius: 250 n miles (463 km)

Accommodation: Pilot only, on Martin-Baker Mk 10H zero/zero rocket ejection seat
Power plant: 1 Rolls-Royce Pegasus Mk 104 vectored-thrust turbofan rated at 95.6 kN (21,500 lb st), with 4 exhaust nozzles of the 2-vane cascade type, rotatable through 98.5° from fully aft position

Avionics
Communications: Plessey PTR 446 D-band IFF transponder and Thomson Thorn ARI 5983 I-band transponder. Radio com by multichannel Magnavox AN/ARC-164 UHF and GEC-Marconi AD 120 VHF with VHF standby via Dowty D 403M transceiver
Radar: Nose-mounted GEC-Marconi Blue Fox multi-mode radar
Flight: UHF homing, GEC-Marconi AD 2770 Tacan with offset facility, Thomson Thorn Microwave Airborne Digital Guidance Equipment (MADGE); radar altimeter; Racal Doppler 72; GEC-Marconi self-aligning attitude and heading reference platform and digital navigation computer, upfront control panel and multifunction display
Mission: Vinten video recording system for HUD and HDD. Smiths digital weapon-aiming computer, bus control unit and missile control system. JTIDS installation planned in 1997. Optically flat panel in nose, on port side, for F.95 oblique camera, which is carried as standard. A cockpit voice recorder with in-flight playback facility supplements the reconnaissance cameras, and facilitates rapid debriefing and mission evaluation
Self-defence: GEC-Marconi Defense Systems Sky Guardian 200 RWR

Sea Harrier FRS Mk 51 (BAe)



BAe Sea Harrier FRS Mk 51 (Jane's/Mike Keep)

Weapon stations
Aircraft are cleared for operations with max external load exceeding 2,270 kg (5,000 lb), but have flown with weapon load of 3,630 kg (8,000 lb). The combat load is carried on four underwing and three underfuselage pylons. The inboard wing points and the fuselage centreline point are stressed for loads up to 907 kg (2,000 lb) each, and outboard underwing pair for loads up to 295 kg (650 lb) each. The two strake fairings under the fuselage can each be replaced by a 30 mm Aden gun pod and ammunition. Four Matra Magic missiles carried on the outboard underwing pylons.

FURTHER INFORMATION

PROGRAMME

The first version of the BAe Sea Harrier was bought by two navies. The British Navy purchased 49 FRS.Mk 1s, of which seven were replacements for aircraft lost in the Falklands (Malvinas) war. The 29 aircraft deployed in that war flew a total of 2,376 sorties; they destroyed 22 Argentine aircraft without loss to themselves in air-to-air combat, but lost four in accidents and two to ground fire.

The Indian Navy had long had a requirement to dominate the Indian Ocean, for which control of the air was clearly essential. It purchased its first aircraft carrier, *Vikrant,* in 1957, which operated Hawker Sea Hawk, fixed-wing, conventional take-off and landing fighter-bombers. As the costs of both aircraft and carriers escalated, however, the Indian Navy decided to follow the British example and to operate V/STOL aircraft from the converted carriers *Vikrant* and *Viraat.* Accordingly, an order for six BAe Sea Harrier Mk 51 single-seaters and two Mk 60 two-seat trainers was placed in 1978, all of which were delivered in 1983/84. This was followed by an order for 10 further Mk 51s and one Mk 60 in 1985, and for another seven Mk 51s and one Mk 60 in 1986.

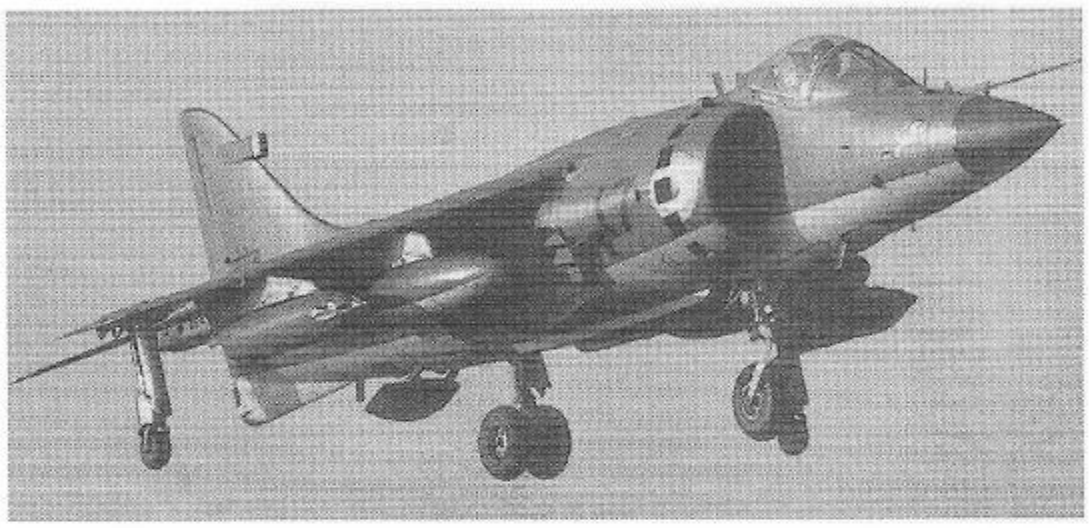
The Sea Harrier Mk 51s are operated by No 300 Squadron, either at sea aboard the carriers or from the unit's shore base at Goa. The two surviving T Mk 60s and one single-seater are operated by the operational conversion unit, 551 Squadron, also located at Goa. The Indian Navy has no known plans to purchase an export version of the Sea Harrier FA.2, but an upgrade for the 22 remaining aircraft was under discussion with BAe in 1994-95, which could possibly include retrofitting the Blue Vixen radar.

DESIGN

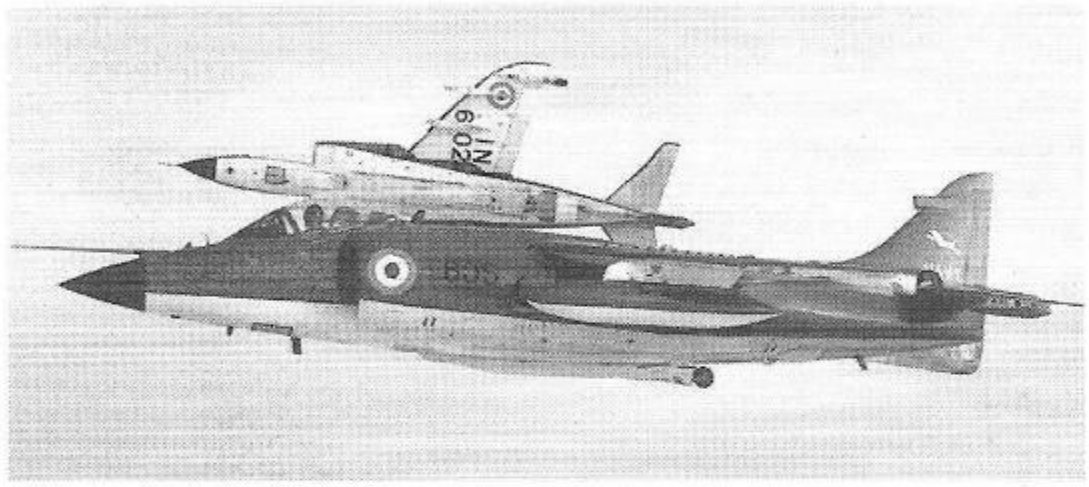
Like all other versions of this aircraft, the Sea Harrier FRS. Mk 51 has a single-engined V/STOL system with four rotatable exhaust nozzles which can be rotated through 98.5° from the fully aft position. Short take-offs are made with nozzles initially fully aft, then turned partially downward for lift-off and continued forward acceleration. The nozzles can be vectored at high speed to tighten turn radius or to decelerate suddenly, a tactic devised by USMC pilots and known as VIFFing (vectoring in forward flight). At less than wingborne airspeed control is automatically transferred to reaction control valves located at the wingtips, nose and tail.

The main differences between sea- and land-based Harriers include the elimination of magnesium components, introduction of a raised cockpit, revised operational avionics, and installation of multimode GEC-Marconi radar with air-to-air intercept and air-to-surface modes in a redesigned nose that folds to port. In addition, the Pegasus 104 turbofan incorporates additional anti-corrosion features and generates more electrical power than land-based Pegasus 103.

The one-piece aluminium alloy three-spar safe-life wing with integrally machined skins is removable as a complete unit to provide access to the engine. There is a three-axis limited authority autostabiliser for V/STOL flight.



Indian Navy Sea Harrier FRS Mk 51 (Indian Navy)



Indian Navy Sea Harriers enabled the life of the two carriers to be extended to the end of the century (BAe)

BRITISH AEROSPACE SEA HARRIER FA.2

AIRCRAFT

Roles: V/STOL interceptor, reconnaissance, strike

In naval service: UK Navy

SPECIFICATIONS

Dimensions
Wing span:
normal: 7.70 m (25.25 ft)
ferry: 9.04 m (29.66 ft)
Length:
overall: 14.17 m (46.5 ft)
nose folded: 13.16 m (43.17 ft)
Height overall: 3.71 m (12.17 ft)
Tailplane span: 4.24 m (13.92 ft)
Outrigger wheel track: 6.76 m (22.17 ft)
Wheelbase, nosewheel to mainwheels: Approx 3.45 m (11 ft 4 in)
Gross wing area: 18.68 m² (201.1 sq ft)

Weights
Operating, empty: 6,374 kg (14,052 lb)
Max fuel:
internal: 2,295 kg (5,060 lb)
external: 2,404 kg (5,300 lb)
Max weapon load:
STO: 3,630 kg (8,000 lb)
VTO: 2,270 kg (5,000 lb)
Max take-off weight: 11,880 kg (26,200 lb)

Performance
Never exceed speed at high altitude: 716 kts (1,328 km/h)
Max level speed at low altitude: 640+ kts (1,185+ km/h)
Typical cruising speed — high altitude, over 1 h, internal fuel: 459 kts (850 km/h)

Combat profiles: (FA.2, operating from carrier with a 12° ski-jump ramp; ISA + 15°C; 20 kts (37 km/h) wind over the deck)
Combat air patrol (CAP): 137 m (450 ft) deck run, followed by up to 1 hour 30 minutes on station at a radius of 100 n miles (185 km) carrying four AMRAAMs, or 2 AMRAAMs and 2—30 mm guns, plus 2—864 litres (228 US gallon) combat drop tanks. Vertical landing.
Reconnaissance: 107 m (350 ft) deck run, followed by low-level cover of 130,000 n miles² (446,465 km²) area at a radius of 525 n miles (970 km) from the carrier, with outward and return flights at medium/high level, carrying 2—30 mm guns and 2—864 litres (228 US gallon) combat drop tanks. Overall flight time 1 hour 45 minutes. Vertical landing on return
Surface attack (hi-lo-hi): 92 m (300 ft) deck run, with radius of action to missile launch 200 n miles (370 km; 230 miles), carrying 2 Sea Eagle missiles and 2—30 mm guns. Vertical landing on return
Interception: A typical deck-launched interception could be performed against a Mach 0.9 target at a radius of 116 n miles (215 km), or a Mach 1.3 target at 95 n miles (175 km), after initial radar detection of the approaching target at a range of 230 n miles (425 km; 265 miles), with the Sea Harrier at 2 minutes alert status, carrying two AMRAAM missiles

Accommodation: Pilot only, on Martin-Baker Mk 10H zero/zero rocket ejection seat
Power plant: 1 Rolls-Royce Pegasus Mk 104 vectored-thrust turbofan rated at 95.65 kN (21,500 lb st), with 4 exhaust nozzles of the 2-vane cascade type, rotatable through 98.5° from fully aft position

Avionics
Communications: Plessey PTR 446 D-band IFF transponder and Thomson Thorn ARI 5983 I-band transponder. Radio communications by multichannel Magnavox AN/ARC-164 UHF and GEC-Marconi AD 120 VHF with VHF standby via Dowty D 403M transceiver
Radar: Nose-mounted GEC-Marconi Blue Vixen multimode radar.
Flight: UHF homing, GEC-Marconi AD 2770 Tacan with offset facility, Thomson Thorn Microwave Airborne Digital Guidance Equipment (MADGE); radar altimeter; Racal Doppler 72; GEC-Marconi self-aligning attitude and heading reference platform and digital navigation computer, upfront control panel and multifunction display
Mission: Vinten video recording system for HUD and HDD. Smiths digital weapon-aiming computer, bus control unit and missile control system. Optically flat panel in nose, on port side, for F.95 oblique camera, which is carried as standard. A cockpit voice recorder with in-flight playback facility supplements the reconnaissance cameras, and facilitates rapid debriefing and mission

A view of a Sea Harrier FA.2 carrying an AIM-9M Sidewinder, long-range tanks and two 30 mm Aden gun pods (RN/HMS *Heron)*

evaluation. (Planned JTIDS installation has been cancelled.)

Self-defence: GEC-Marconi Defence Systems Sky Guardian 200 RWR

Weapon stations

There is no built-in armament, the combat load being carried on four underwing and one underfuselage pylons, all fitted with ML ejector release units. The inboard wing points and the fuselage centreline point are stressed for loads up to 907 kg (2,000 lb) each, and outboard underwing pair for loads up to 454 kg (1,000 lb) each. The two strake fairings under the fuselage can each be replaced by a 30 mm Aden gun pod and ammunition or by two AIM-120 AMRAAMs. Aircraft are cleared for operations with a max external load exceeding 2,270 kg (5,000 lb). Alternative stores include free-fall and parachute retarded bombs, and, until they were withdrawn from service, WE 177 nuclear weapons. Four AIM-9 Sidewinders or four AIM-120 AMRAAMs can be carried and there is provision for two Sea Eagle or Harpoon anti-ship missiles.

A pair of original Sea Harrier FRS.1 on patrol; note the sharp nose and long pitot tube (RN/FOSF)

FURTHER INFORMATION

PROGRAMME

The first version of the BAe Sea Harrier was bought by two navies. The British Navy purchased 49 of the FRS. Mk 1, of which seven were replacements for aircraft lost in the Falklands (Malvinas) war. The 29 aircraft deployed in that war flew a total of 2,376 sorties, destroying 22 Argentine aircraft without loss to themselves in air-to-air combat, although four were lost in accidents and two to ground fire.

Development of the FA.2 (Fighter Attack Mk 2) started in 1985 and the first of two test aircraft flew in September 1988. The initial production contract, placed in 1989, was for the conversion of 31 FRS.1s to FA.2 standard, but in 1990 a further contract for 10 new-build FA.2s was added, followed by another in 1994 for 18 more new-builds and five more conversions. In addition, four T.Mk 8N have been produced by converting T. Mk 4Ns to duplicate the new FA.2s' systems, apart from the Blue Vixen radar.

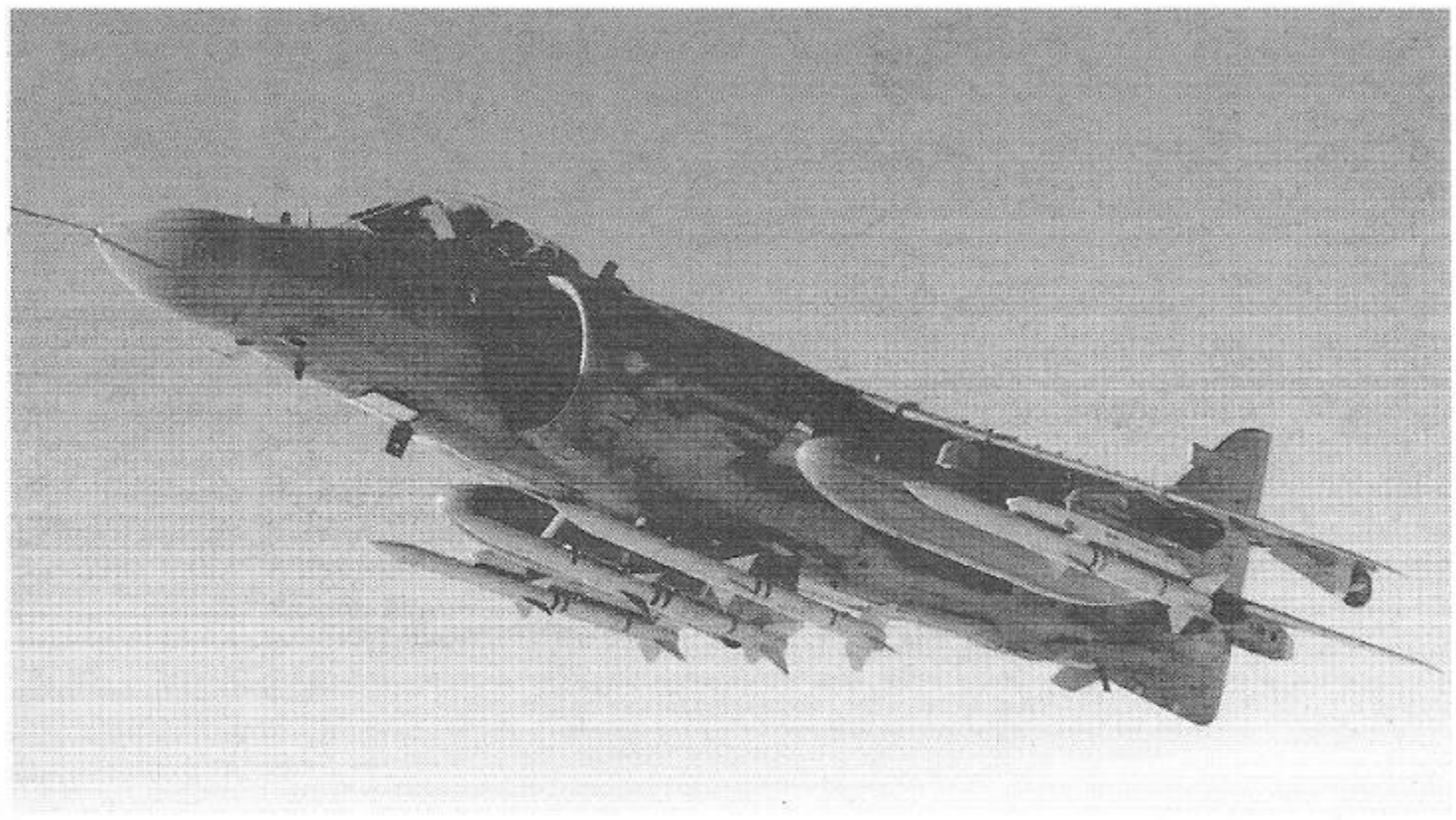
DESIGN

The British Navy's Harrier FA.2 differs externally from the initial version in having a less pointed radome, a rear fuselage extended by a 35 cm (12.6 in) plug inserted just aft of the wing trailing edge, and revised antennas and stores carriers. Despite this plug, the overall length of the FA.2 is actually less than that of the FRS.1, since the latter's pitot tube has been removed. Internally, the changes are much greater, with a Blue Vixen all-weather look-down/shoot-down radar, which has inherent track-while-scan capability, multiple target engagement and greatly enhanced performance. The cockpit has also been redesigned and HOTAS controls installed. The aircraft is also able to carry the Hughes AIM-120 AMRAAM air-to-air missile.

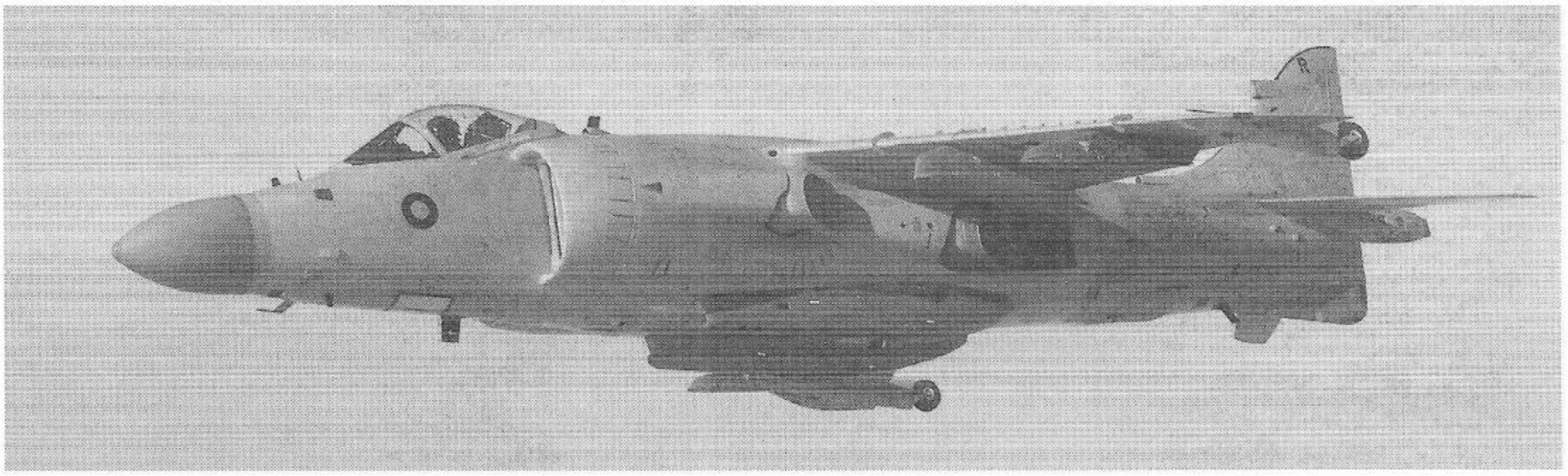
Ski ramp

All naval operators of the Harrier/Sea Harrier except for the US Navy, use a ski ramp to enhance the aircraft's performance. This device was proposed by Lieutenant Commander DR Taylor, RN, and was first used in take-off trials ashore in 1977, and at sea on 30 October 1980. The first British carriers to be fitted with the device had 7° ramps, but this was followed by 12° ramps and the latest has a 13° angle.

The ski ramp enables the aircraft to take-off either with a much greater all-up weight for the same take-off run, or with the same weight, to use a much shorter run. Thus, for example, the 12° ramp enables the Sea Harrier to either carry an extra 1,135 kg (2,500 lb) or to reduce its take-off run by some 50 to 60 per cent. It also has the benefit of being safer, in that in the event of engine failure during take-off the pilot has much more time in which to decide what action to take. Further, in rough weather the ski ramp ensures that the aircraft has an upward trajectory, even in the worst situation where it launches as the ship pitches downwards into the sea.



BAe Sea Harrier FA.2 development aircraft armed with four Hughes AIM-120 AMRAAM missiles (BAe)



BAe Harrier FA.2 upgraded FRS.1 V/STOL fighter of the British Navy, showing the more rounded nose radome and the absence of a long pitot tube (BAe)

NORTHROP GRUMMAN(GRUMMAN) S-2 TRACKER

AIRCRAFT

Role: Twin-engined anti-submarine aircraft

In naval service: Argentina (9); Brazil (12); South Korea (14); Peru (8); Taiwan (32); Thailand (5); Turkey (14); Uruguay (3); Venezuela (6)

SPECIFICATIONS

(S-2E)
Dimensions
Wing span: 22.13 m (72.60 ft)
Length: 13.26 m (43.5 ft)
Height: 5.06 m (16.60 ft)

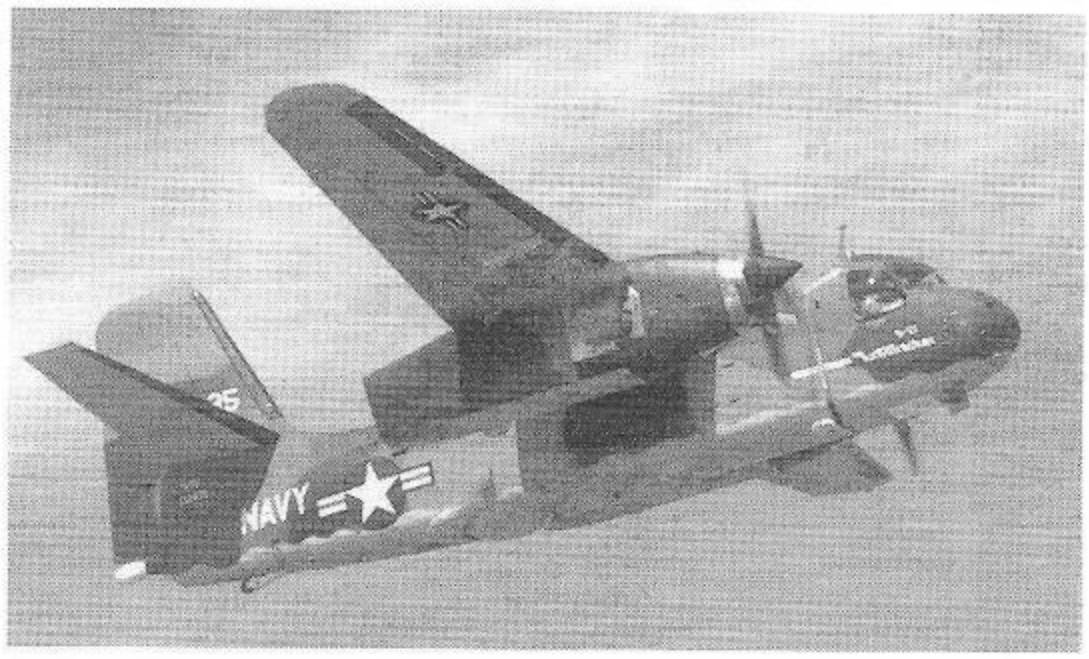
Weights
Operating weight, empty: 8,505 kg (18,750 lb)
Max take-off weight: 13,222 kg (29,150 lb)

Performance
Max level speed, sea level: 230+ kts (426 km/h)
Patrol speed at 450 m (1,500 ft): 130 kts (241 km/h)
Service ceiling: 6,400 m (21,000 ft)
Ferry range: 1,128 n miles (2,095 km/h)
Endurance with max fuel, 10% reserve: 9 h

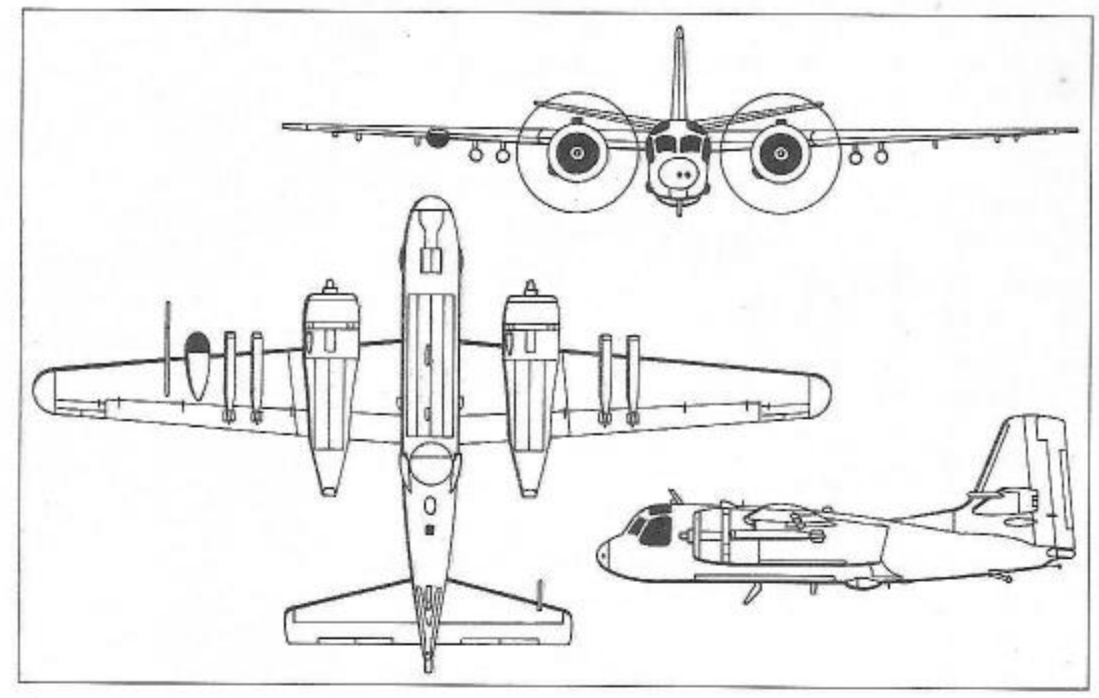
Power plant (S-2E): 2–1,525 hp Wright R-1820-82 WA nine-cylinder, air-cooled, radial engines, driving 3-bladed constant-speed metal propellers

Fuel (Avgas)
Max internal fuel: 1,981 kg (4,368 lb)

Accommodation: Pilot, co-pilot (who is also navigator,



Northrop Grumman's S-2(T) conversion, powered by two Garrett TPE331-15 AW turboprops, rated at 1,645 shp, here flying in US colours as part of the development programme (Northrop Grumman)



Grumman S-2 Tracker twin-engine Anti-Submarine Warfare (ASW) aircraft (Jane's/Mike Keep)

radio operator and searchlight operator), radar operator, MAD operator

Sensors (SH-2D)
Radio: UHF direction-finder; LF direction-finder, Tacan HF/UHF radios, APX-6B and APA-89 IFF
Radar: APN-12 Doppler radar

ASW: AN/AQA-3 Jezebel passive long-range acoustic search equipment using sonobuoys; Sniffer passive submarine exhaust detector; Julie active acoustic echo ranging; retractable ASQ-10 MAD; remotely controlled searchlight under starboard wing; 75 kW X-band radar (in retractable, under-fuselage radome)

Weapons: 2 homing torpedoes or 1 Mk 101 depth bomb, or 4—385 lb depth charges. 6 underwing attachments for torpedoes, 5 in rockets, Zuni rockets or 250 lb bombs. Housing for sonobuoys and marine markers in rear of engine nacelles. Fuselage dispenser for 60 underwater sounding charges for echo ranging

PROGRAMME

The Grumman S-2 Tracker was designed to combine the roles of ASW search and attack in one airframe and the first prototype flew on 4 December 1952, following which Grumman (now Northrop Grumman) has built over 1,000 aircraft. The S-2 has long since been succeeded in US Navy service by the S-3 Viking.

Many S-2s have been exported, both as new-build aircraft and as US Navy surplus. 98 Trackers of various types remain in naval service in the ASW role, although only 21 of these are likely to be found operating from carriers. These are 12 S-2A/Es operated by the Brazilian Air Force from the carrier *Minas Gerais*, and nine S-2E/Ts operated by the Argentine Navy in anticipation of the return to service of the carrier *Veinticinco de Mayo* and which carry out carrier operations annually with the US Navy.

Other users of the S-2 are: South Korea (14 × S-2 A/F); Peru (eight S-2); Taiwan (32 × S-2E/T); Thailand (five S-2F); Turkey (14 × S-2E), Uruguay (three S-2G) and Venezuela (six S-2E).

DESIGN

The pilot and co-pilot sit on the flight deck with two systems operators behind them. The aircraft carries a wide range of sensors, including radar in a retractable ventral dome, an extendable MAD boom in the tail, sonobuoys and explosive charges, and a searchlight on the starboard wing. There is an internal weapons bay together with six underwing stations, and the sonobuoys and explosive charges are carried in the rear of the engine nacelles. The aircraft continues to provide a useful ASW platform, although its main drawbacks are dated avionics and sensors, and the Wright radial engines, using Avgas fuel.

MODERNISATION

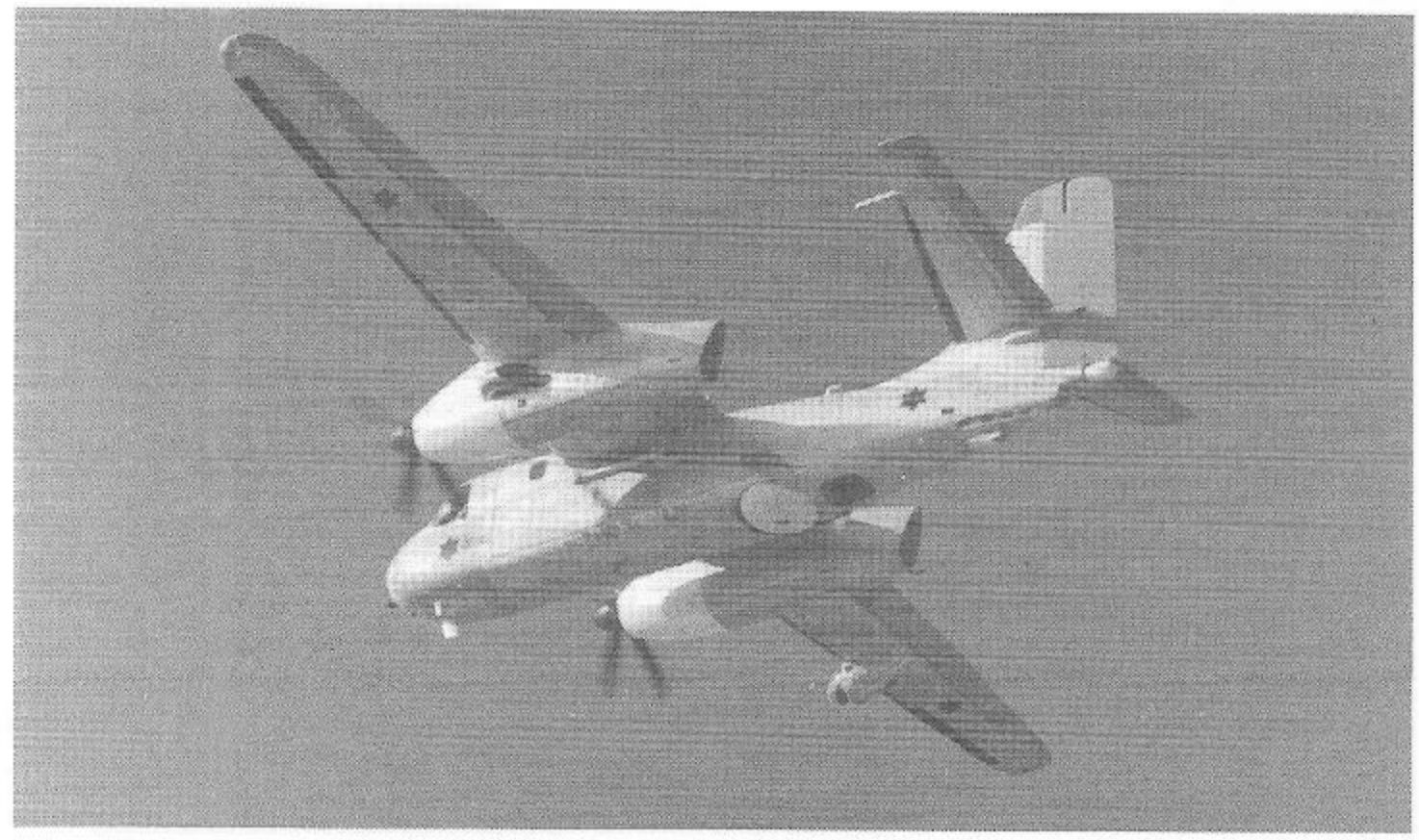
The relatively large number of S-2s still in service has encouraged several companies to market upgrade kits, all of which involve replacing the Wright radial engines with turboprops, while also upgrading the avionics and mission equipment. Curiously, there are three different upgrades on the market, and each has found just one customer.

IAI/Marsh: IAI (Israel Aircraft Industries) teamed with Marsh (Mesa, Arizona, USA) to market an upgrade, designated S2F1T Turbo-Tracker, which includes replacing the original power plant and propellers with Garrett TPE331-15 turboprops driving Hartzell, five-bladed, reversing propellers. Other improvements involve modern air conditioning and oxygen systems; a higher powered searchlight; new autopilot; and an upgrade of other flight systems. The net result is an aircraft with higher payload and take-off weights, and better performance, but which does not lose its carrier take-off and landing capabilities. IAI has upgraded one Argentine Navy Tracker to this standard and has supplied kits for the navy to upgrade five more itself.

IMP: Canadian company IMP Aerospace won a contract from the Brazilian Air Force to convert 12 S-2Es. The work involved fitting Pratt & Whitney PT6A-67CF turboprops rated at 1,230 kW (1,650 shp),

FURTHER INFORMATION

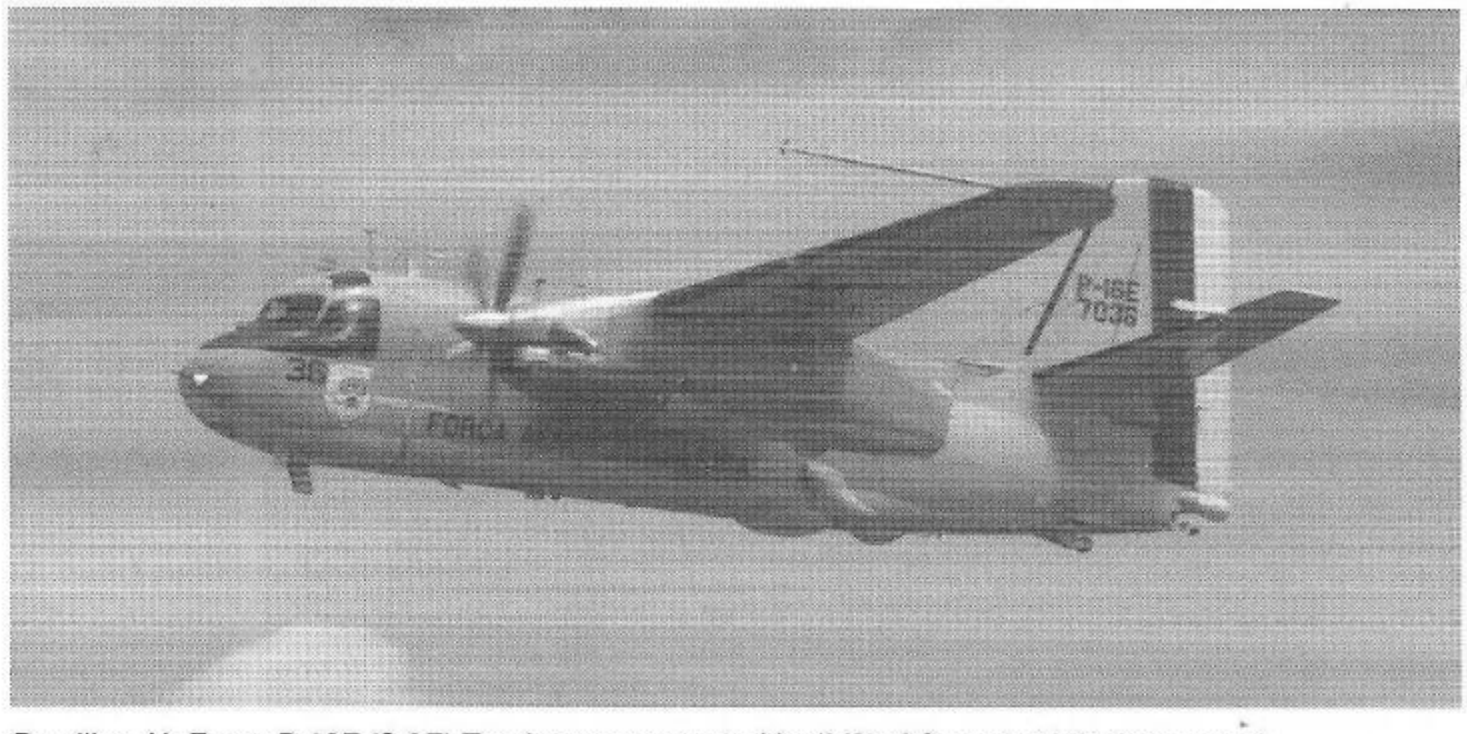
One of the IAI/Marsh S-2UP turboprop-powered Grumman Tracker conversions for the Argentine Navy in temporary Israeli markings. Note the aircraft's asymmetric wing-folding system (IAI)



The IAI/Marsh S-2UP from below (IAI)

Hartzell five-bladed propellers, and modified fuel, hydraulic, pneumatic and electrical systems. The prototype conversion was delivered to Brazil in December 1990 where it successfully underwent trials aboard the *Minas Gerais*. However, the Brazilian Government then cancelled the contract for the conversion of the remaining 11 aircraft.

Grumman: The original manufacturers, Grumman, also developed an upgrade programme at the request of the US Navy for export under a $260 million FMS contract. The work involved installing Garrett TPE331-15AW turboprops, rated at 1,640 shp each, driving Dowty four-bladed propellers. New avionics included GEC Avionics MAPADS 902F acoustic processor, AN/ASQ-504(V) MAD detector, AN/APS-509 radar, AN/ARR-84 acoustic receivers, AN/ASN-0150 tactical navigation system coupled with the 72R inertial navigation system, and Rockwell-Collins radios. This resulted in a speed of 270 kts (500 km/h) at 1,525 m (5,000 ft), an increase of 500 kg (1,102 lb) in payload, and concomitant improvements in cruising speed, field lengths, single-engined performance and time between overhauls (TBO). The Republic of China (Taiwan) ordered 32 S-2Es for conversion, with the first being modernised by Grumman, who then supplied 30 kits for the other airframes to be modernised in Taiwan. The RoC Navy intends to produce 30 S-2Ts for the ASW role and two for EW.



Brazilian Air Force P-16E (S-2E) Tracker, as converted by IMP of Canada (IMP Aerospace)

South Korea and Thailand are also known to be considering the possibility of upgrading their aircraft to include turboprop engines.

NORTHROP GRUMMAN (GRUMMAN) EA-6B PROWLER

AIRCRAFT

Role: Four-seat carrierborne ECM aircraft

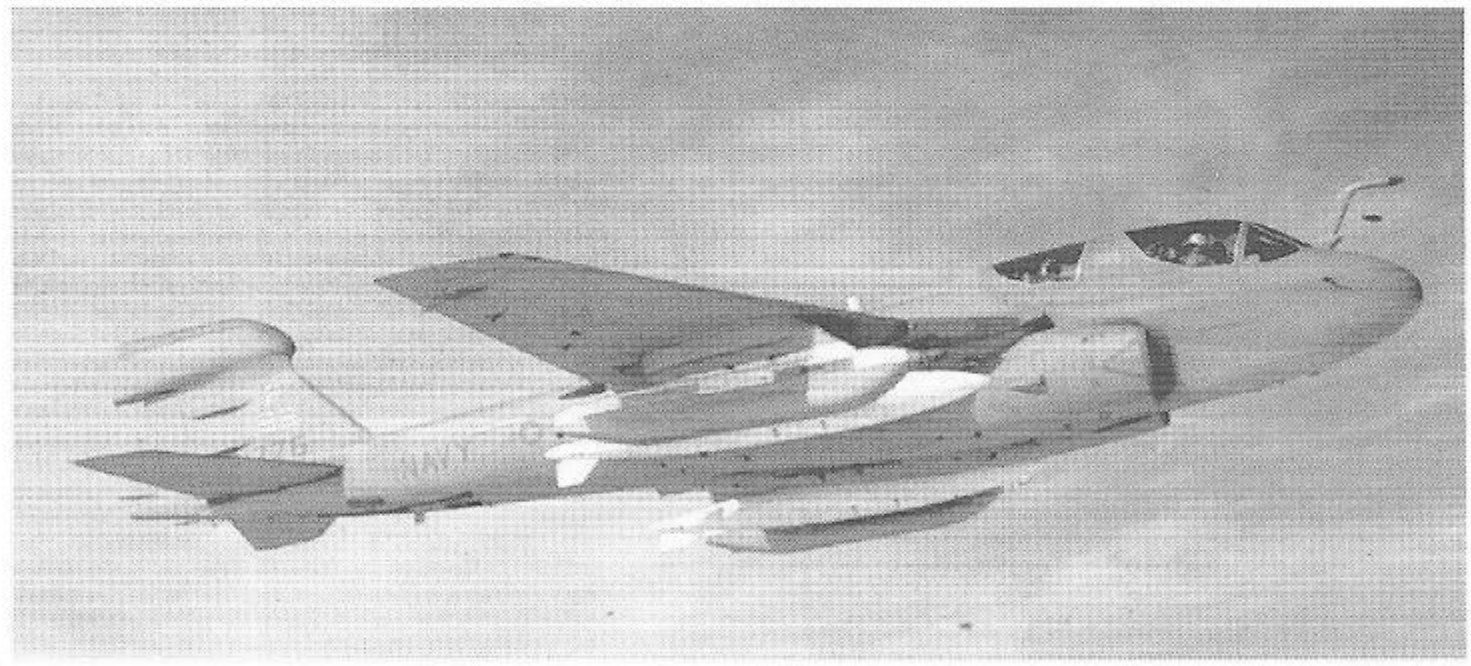
In naval service: USA (102)

SPECIFICATIONS

(EA-6B ICAP-2)
Dimensions
Wing span: 16.15 m (53.00 ft)
Wings folded: 7.87 m (25.82 ft)
Length: 18.24 m (59.84 ft)
Height: 4.95 m (16.25ft)

Weights
Operating weight, empty: 14,321 kg (31,572 lb)
Max take-off weight from carrier in standoff jamming configuration (five ECM pods): 24,688 kg (54,383 lb)
Max take-off weight, catapult or field: 29,483 kg (65,000 lb)

Performance (A = clean; B = five ECM pods)
Never-exceed speed: 710 kts (1,315 km/h)
Max level speed, sea level:
A: 566 kts (1,048 km/h)
B: 530 kts (982 km/h)
Cruising speed at optimum altitude:
A, B: 418 kts (774 km/h)
Service ceiling:
A: 12,550 m (41,200 ft)
B: 11,580 m (38,000 ft)
Range with max external load, 5% reserves, plus 20 min at sea level:
B: 955 n miles (1,769 km)
Ferry range with max external fuel:
tanks retained: 1,756 n miles (3,254 km)
tanks jettisoned when empty: 2,085 n miles (3,861 km)



Northrop Grumman EA-6B Prowler (Northrop Grumman)

Power plant: 2 Pratt & Whitney J52-P-408 turbojets, each rated at 49.8 kN (11,200 lb st)
Accommodation: Pilot and 1 ECM officer (ECMO) in front cockpit; 2 ECMOs in rear cockpit. Both ECMOs operate the AN/ALQ-99 equipment in the rear cockpit and either can operate the jammers. Front-seat ECMO is responsible for communications, navigation, defensive ECM and chaff dispensing
Sensors: AN/ALQ-99F tactical jamming system in five, integrally powered pods, with a total of 10 jamming transmitters. Each pod covers one of seven frequency pods. Surveillance receivers are mounted in the fin-tip pod for long-range detection of radars; emitter is fed to to a central digital computer that processes the signals for display and recording. PRB Associates AN/TSQ-142 tactical mission support sytem. Teledyne Systems AN/ASN-123 navigation system with digital display group.
Weapons: Originally unarmed, but currently capable of carrying Texas Instruments AGM-88A HARM anti-radar missiles, underwing. Four underwing hardpoints for ICAP-2 aircraft and six on ADVCAP EA-6B.

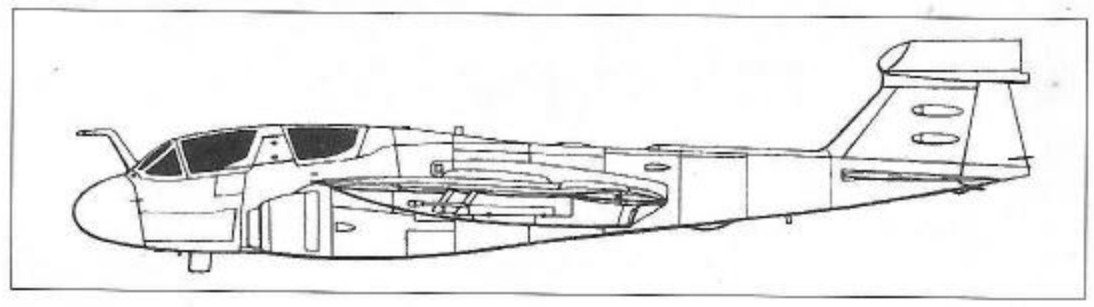
FURTHER INFORMATION

PROGRAMME

The development contract for an electronic warfare version of the A-6 Intruder was placed in 1966 and resulted in an aircraft which differed mainly in having a longer nose to accommodate a four-crew cockpit and a large pod atop the fin. First flight took place in May 1968 and the initial production aircraft were delivered in January 1971.

The five prototypes and first 23 production airframes were built to the initial 'standard' which was replaced by the 'Expanded Capability' (EXCAP) for the next 25 off the production line. Next came the 'Improved Capability – 1' (ICAP-1) version, which had increased jamming capacity; reduced response time; multiformat displays; automatic, all-weather carrier landing system (ACLS); new defensive ECM; and new communications, navigation and identification equipment. 45 new aircraft were built to ICAP-1 standard, while 21 of the 'standard' and 'EXCAP' models were modified up to the configuration.

Then came the current system, ICAP-2, for which the prototype flew in 1980, which is the type described in the 'specifications' above, with all the enhancements being to the electronic and avionic systems rather than to the aircraft itself. There are three minor variations within ICAP-2: the first 12 were baseline aircraft,



Northrop Grumman EA-6B Prowler (Jane's/Mike Keep)

Northrop Grumman EA-6B Prowler receives the signal to launch (US Navy/PH1 William A Shayka)

followed by 23 Block 82s which can carry the HARM missile and, finally, 37 Block 86s with enhanced signal processing and an expanded communications system.

Production ended in July 1991, and a new Advanced Capability (ADVCAP) was planned to keep the aircraft's systems up to date, at a cost of $60 million per aircraft. This was, however, cancelled in 1994, but since it is planned to retain the EA-6B in service until 2020 some form of further enhancement programme will eventually be required. Seven aircraft were, in fact, modified to test the ADVCAP system, which includes fitting the Lockheed Sanders AN/ALQ-149 communications jammer, the replacement of the existing engines by the more powerful J52-P-409 rated at 53.38 kN (12,000 lb st) and other improvements. Block 2000 proposes even further enhancements, including JTIDS, satellite communications and survivability measures.

There are currently some 102 EA-6Bs in the US Navy inventory, serving in 13 squadrons of 4-6 aircraft each. One squadron serves in each carrier air wing.

NORTHROP GRUMMAN (GRUMMAN) E-2C HAWKEYE

AIRCRAFT

Type: Shipborne and land-based airborne early warning and control aircraft

In naval service: Egypt (6); France (2 on order, plus 2 options); Israel (4); Japan (13); Singapore (4); Taiwan (4); USA (99)

SPECIFICATIONS

Dimensions
Wing span: 24.56 m (80.58 ft)
Width, wings folded: 8.94 m (29.33 ft)
Length overall: 17.60 m (57.74 ft)
Height overall: 5.58 m (18.31 ft)
Tailplane span: 7.99 m (26.21 ft)
Wheel track: 5.93 m (19.45 ft)
Wheelbase: 7.06 m (23.16 ft)
Diameter of rotodome: 7.32 m (24.0 ft)
Propeller diameter: 4.11 m (13.50 ft)
Wing area, gross: 65.03 m² (700.0 sq ft)

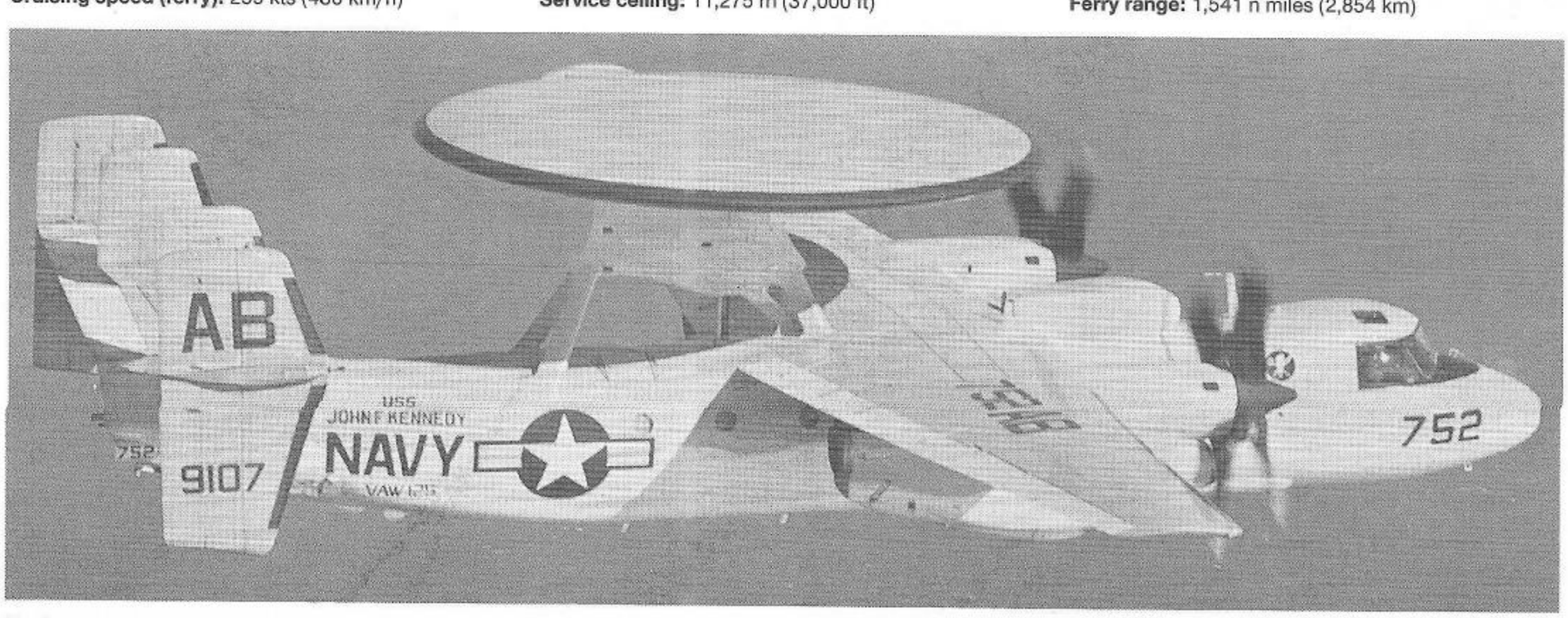
Weights
Weight empty: 18,363 kg (40,484 lb)
Max take-off weight: 24,687 kg (54,426 lb)

Performance (at max take-off weight)
Max level speed: 338 kts (626 km/h)
Max cruising speed: 325 kts (602 km/h)
Cruising speed (ferry): 259 kts (480 km/h)

E-2C on final approach to an airfield (Jane's/H M Steele)

Approach speed: 103 kts (191 km/h)
Stalling speed (landing configuration): 75 kts (138 km/h)
Service ceiling: 11,275 m (37,000 ft)

Min take-off run: 564 m (1,850 ft)
Take-off to 15 m (50 ft): 793 m (2,600 ft)
Min landing run: 439 m (1,440 ft)
Ferry range: 1,541 n miles (2,854 km)



E-2C of the US Navy (US Navy)

Time on station, 175 n miles (320 km) from base: 4 h 24 min
Endurance with max fuel: 6 h 15 min

Power plant: 2–3,803 kW (5,100 ehp) Allison T56-A-427 turboprops, driving Hamilton Standard Type 54460-1 4-blade fully feathering reversible-pitch constant-speed propellers

Fuel:
max fuel (internal, usable): 5,624 kg (12,400 lb)
external fuel: none

Accommodation: Pilot and co-pilot on flight deck, plus Combat Information Center (CIC) staff comprising: combat information centre officer, air control officer and radar operator

Avionics
Communications: AN/AIC-14A intercom
Flight: Litton AN/ASN-92 CAINS (carrier aircraft inertial navigation system), AN/ASW-25B ACLS (advanced carrier-landing system), GPS (global positioning system), AN/ASN-50 heading and attitude reference system, Collins AN/ARA-50 UHF ADF, GEC-Marconi standard central air data computer, ASM-400 in-flight performance monitor, Honeywell AN/APN-171(V) radar altimeter

E-2C Hawkeye aboard a carrier (US Navy)

Radar: Lockheed Martin AN/APS-145 advanced radar processing system (ARPS) with fully automatic over-land/overwater detection capability, Randtron AN/APA-171 rotodome (radar and IFF antennae)
Mission: Hazeltine AN/APA-172 control indicator group with Loral enhanced (colour) main display units, Litton OL-77/ASQ computer programmer (L-304) with Loral enhanced high-speed processor, Hazeltine IFF detector processor, Litton AN/ALR-73 passive detection system, AN/ARC-158 UHF datalink, AN/ARQ-34 HF datalink and JTIDS Class 2 HP terminal
Weapons: None

FURTHER INFORMATION

PROGRAMME

The first of three E-2A prototypes flew on 21 October 1960 and a total of 59 E-2As was produced. 51 E-2As were subsequently updated to E-2B standard by the end of 1971, and two were converted to TE-2A trainers, while another two served as prototypes for the E-2C.

The first flight of an E-2C prototype took place on 20 January 1971 and production started in mid-1971. The first production E-2C flew on 23 September 1972, and of 177 originally ordered, at a production rate of six per year, 170 had been delivered by the start of 1995.

US Navy E-2Cs have been procured with three different fits. The original Group 0 aircraft have the APS-125 radar and 100 were delivered. These were followed by 18 Group I aircraft with the APS-139 radar and Allison T56-427 engines, of which the first was delivered in August 1989. Next came Group II, the first of which was delivered in December 1991 which has the APS-145 radar; this is still the current production version.

For stowage the wings fold hydraulically on skewed hinges to lie parallel to fuselage, and the rotodome is lowered by jacks to enable the aircraft to fit into the hangar. The tailplane has four fins in order to provide the required area without being too high to fit into the hangar. For the pilot, the aircraft's long wing span (24.56 m (80.58 ft)) means that landings must be very precise, since there is little spare space on the carrier flight deck.

NAVAL VARIANTS

E-2B: Withdrawn from USN service
E-2C: Current service and production version (as detailed)
TE-2C: Training model, based on E-2C
E-2T: This designation was originally applied to a proposed conversion of the E-2B for Taiwan with AN/APS-138 radar and electronic warfare upgrades. This version was later abandoned in favour of new-build E-2Cs, for which the E-2T designation was retained
Daya (Kite): Israel Defence Force name for their E-2Cs

US Navy
E-2C entered service in November 1973 and went to sea on board USS *Saratoga* late 1974 and is currently operated by 18 other squadrons, including two of Naval Reserve. Two TE-2Cs are in service, one of which is assigned to JTIDS development.

All carrier air wings include E-2Cs, with four each in the transitional and power projection air wings, and three in the 50 TACAIR air wing.

Exports
The E-2C has been exported to certain selected US allies:
Egypt (6 — Group 0); France (2 — Group II); Israel (4 — Group 0); Japan (13 — Group 0); Singapore (4 — Group 0); and Taiwan (4 — Group II). Of these, all use the E-2C as a land-based AEW aircraft, except for the French, who will use their aircraft from the carrier *Charles de Gaulle* when that ship enters service.

France signed a Letter of Offer and Acceptance (LOA) in June 1995 for two aircraft, which will be delivered in the fourth quarter of 1997 for aircrew training. Two aircraft are, however, scarcely a viable force and it is strongly expected that the French Navy will eventually obtain a total of four. The cost of the French procurement of two aircraft illustrates the expense of this admittedly very capable aircraft: approximately US $562 million, including logistics support.

The Japanese aircraft are all Group 0, but have been upgraded with the AN/APS-145 radar.

The Singaporean aircraft have the AN/APS-138 radar.

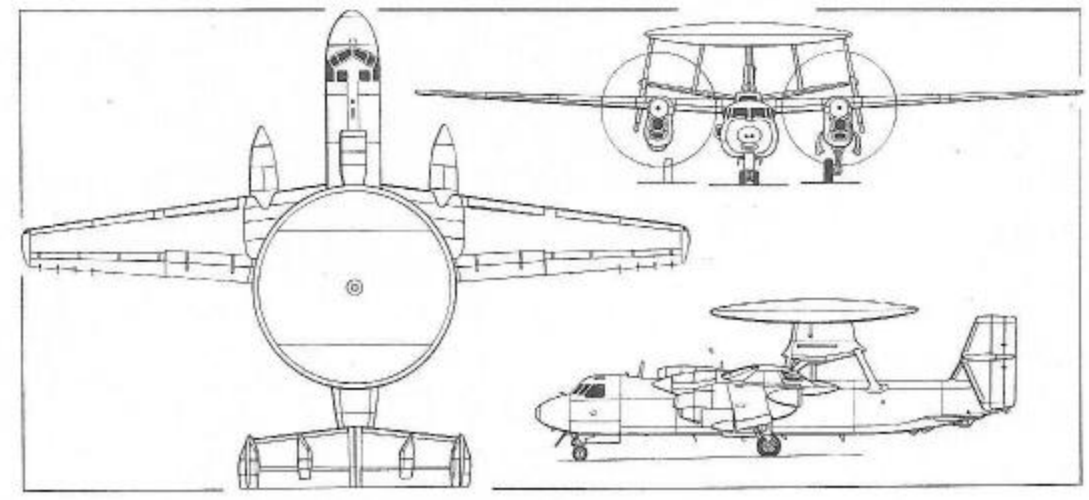
Taiwan originally required the E-2T, a converted E-2B with AN/APS-138 radar, but it was then decided to take the standard production E-2C Group II. The fourth and last Taiwanese E-2T, which was completed in November 1994, was also the final Hawkeye built at the Calverton plant, all subsequent production being at the new plant at St Augustine.

Further export sales are likely to include the additional two for France, another two for Singapore and a new customer, Thailand, which has a requirement for four.

OPERATIONAL

The E-2 Hawkeye provides early warning cover for a naval task force in all weathers, flying at a height of 9,150 m (30,000 ft), where it can detect and assess approaching aircraft at distances in excess of 300 n miles (556 km) and sea-skimming missiles at ranges of about 160 n miles (258 km). In US Navy service, the E-2C relays early warning information to the carrier's combat information centre (CIC), which then scrambles F-14 fighters to deal with the incoming targets. The E-2 has a datalink with the F-14s, which is used for a two-way exchange of data, the E-2C providing the F-14 with vector information, while the F-14's radar updates the E-2C's system. The E-2C can also exercise airspace management for strikes, rescue operations and air traffic control.

The main radar has been constantly upgraded from the original AN/APS-120 in the E-2A, through AN/APS-125, AN/APS-138 and AN/APS-139 to the current AN/APS-145. The original E-2C Group 0 has the AN/APS-138, while the Group 1 has the AN/APS-139



Northrop Grumman E-2C (Jane's/Dennis Punnett)

E-2C showing its AN/APA-171 antenna housing, which is 7.32 m (24 ft) in diameter (Northrop Grumman)

(together with Allison T56-427 engines). 18 Group 1 aircraft were built, the first being delivered in August 1989. The AN/APS-139 can detect cruise missiles at ranges exceeding 100 n miles (185 km) and also monitors maritime traffic. Radar coverage is extended by the AN/ALR-73 passive detection system (PDS), which detects electronic emitters at twice the previous radar detection range.

Group 2 aircraft, delivered from December 1991 onwards, have the Grumman/Lockheed Martin AN/APS-145. This latest system has the total radiation aperture control antenna (TRAC-A) to reduce sidelobes and thus offset jamming, and its radar sweeps a six million cubic mile envelope and simultaneously monitors surface ships. Long-range, automatic target track initiation and high-speed processing enable each E-2C to track more than 2,000 targets simultaneously and automatically, and to control more than 40 intercepts. In all, the enhancements give a 96 per cent expansion in radar volume, 400 per cent extra target tracking capability, 40 per cent more radar and identification range and 960 per cent increase in numbers of targets displayed. Group II aircraft also have GPS, while JTIDS was added in 1993-94.

The Randtron Systems AN/APA-171 antenna is housed in the 7.32 m (24 ft) diameter rotodome, which is mounted above the rear fuselage and rotates at 5-6 rpm. The antenna arrays inside the rotodome provide radar sum and difference signals and IFF.

MODERNISATION

A major retrofit programme for US Navy and FMS supplied aircraft was planned, which would have involved upgrading a minimum of 36 of the original 'Group 0' and all 18 Group I aircraft to Group II standard, starting in FY95. The 1994 defence review, however, established that new E-2Cs were a more economical proposition.

Despite this cancellation, the company received a $155 million contract in December 1994 to upgrade the mission computer. The new equipment is to be based on Raytheon's Model 940, itself a modification of Digital Equipment Corporation 2100 Model A500MP processing system, which is the same family of hardware as that used in the E-8C Joint-STARS.

For the longer term, the US Navy considered the Advanced Tactical Support (ATS) aircraft programme, which included an AEW configuration to replace E-2C. The ATS was, however, cancelled in 1991 and the navy is now considering the launch of an 'E-X' programme for a follow-on AEW, although apparently no funding is available in defence budgets before 2000.

NORTHROP GRUMMAN (GRUMMAN) F-14 TOMCAT

AIRCRAFT

Role: Two-seat carrierborne interceptor with attack capability

In naval service: USA (436)

SPECIFICATIONS

Dimensions
Wing span:
unswept (20°): 19.54 m (64.11 ft)
swept (68°): 11.65 m (38.22 ft)
overswept (75°): 10.15 m (33.30 ft) (carrier stowage only)
Length, overall: 19.10 m (62.66 ft)
Height, overall: 4.88 m (16.01 ft)
Wheel track: 5.00 m (16.42 ft)
Wheelbase: 7.02 m (23.03 ft)

Weights (F-14D with F110-GE-400 engines)
Operating weight, empty: 18,951 kg (41,780 lb)
Take-off weight:
fighter/escort mission: 29,072 kg (64,093 lb)
fleet air defence mission: 33,157 kg (73,098 lb)
max: 33,724 kg (74,349 lb)
Max external weapons: 6,577 kg (14,500 lb)

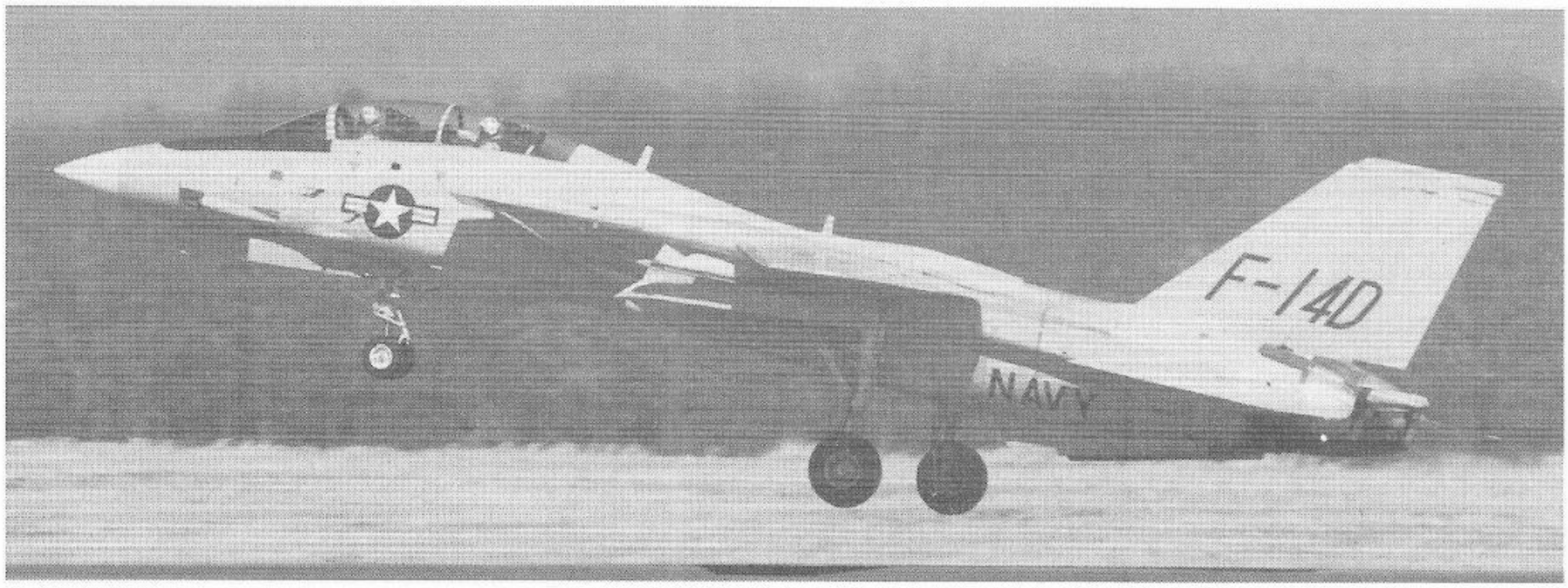
Performance
Max level speed, sea level: Mach 1.88
Max cruising speed: Mach 0.72
Carrier approach speed: 125 kts (232 km/h)
Service ceiling: Above 16,150 m (53,000 ft)
Field range with external fuel: Approx 1,600 n miles (2,965 km)

Power plant: 2 General Electric F110-GE-400 turbofans, each rated at 71.56 kN (16,088 lb st) and 120.1 kN (27,000 lb st) with afterburner

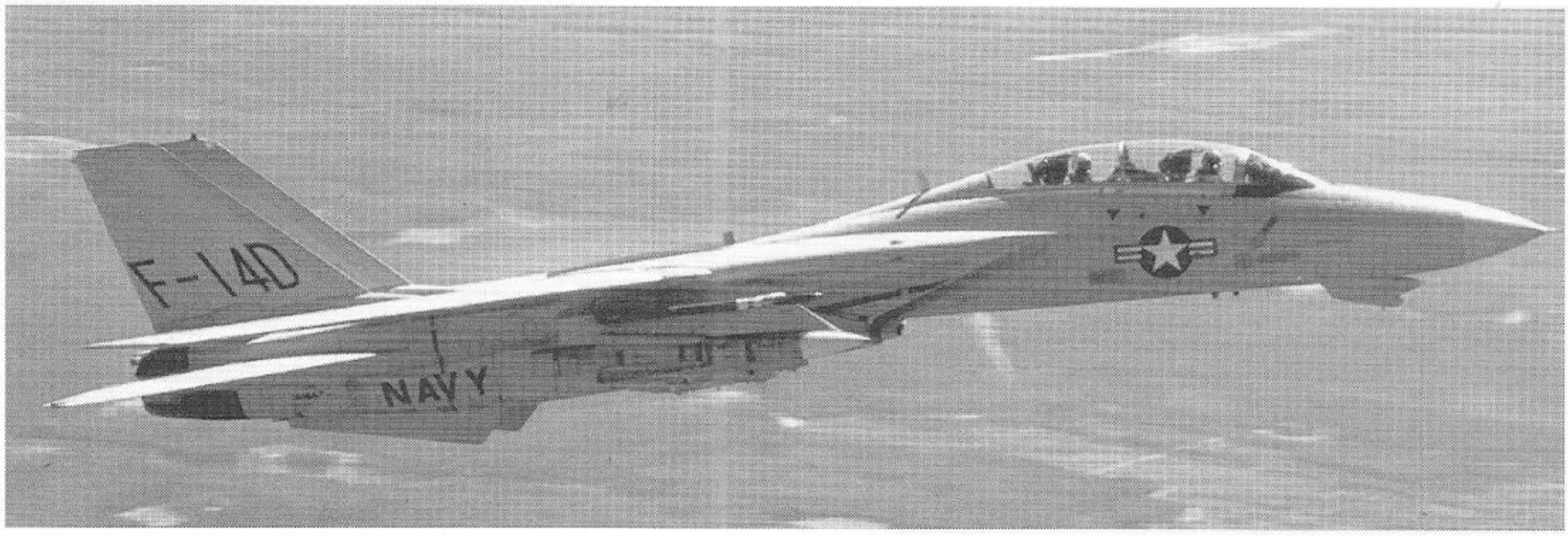
Fuel:
internal: 9,029 litres (2,385 US gallons)
external: 2 tanks, 1 beneath each intake trunk, each containing 1,011 litres (267 US gallons)
Max usable fuel:
internal: 7,348 kg (16,200 lb)
external: 1,724 kg (3,800 lb)

Accommodation: Pilot and naval flight officer seated in tandem on Martin-Baker NACES (or GRU7A in F-14A/B) rocket-assisted, zero/zero ejection seats

Avionics
F-14A/B: Hughes AN/AWG-9 weapons control system (can detect airborne targets at ranges greater than 65-170 n miles (120-315 km) according to their size; also tracks 24 enemy targets and can attack six of them simultaneously at varied altitudes and distances). Also, Fairchild AN/AWG-15F fire-control set; CP-1066/A central air data computer; CP-1050/A computer signal data converter; AN/ASW-27B digital datalink; AN/APX-76(V) IFF interrogator; AN/APX-72 IFF transponder; AN/ARC-51 and AN/ARC-159 UHF communications; AN/ARR-69 UHF auxiliary receiver; KY-28 cryptographic system; AN/ASN-92(V) INS; A/A24G39 AHRS; AN/APN-154 beacon augmenter; AN/ARN-84 micro TACAN; AN/ARA-50 UHF ADF; AN/APR-27/50 radar receiver; AN/APR-25/45 radar warning set; Northrop Corp TV camera set (TCS) in undernose pod (TCS automatically searches for, acquires, and locks on to distant targets, displaying them on monitors for the pilot and flight officer); Sanders AN/ALQ-100/126 deception jamming system (housed in a small undernose pod, which is relocated under the camera package in TCS-fitted aircraft)
F-14D: In F-14D, some 60 per cent of analogue avionics are made digital, giving new weapon management, navigation, displays and control functions. MIL-STD-1553B digital databus interconnects Litton AN/ALR-67 threat warning and recognition system, JTIDS, GE Aerospace Electronic Systems infra-red search and track sensor (IRST) and TCS. Hughes AN/APG-71 radar (replacing AN/AWG-9), provides improved ECM, monopulse angle tracking, digital scan control, target identification and raid assessment; non-co-operative target identification and ECM using low-sidelobe antenna and sidelobe blanking guard channel, frequency agility, and new high-speed digital signal



Northrop Grumman (Grumman) F-14D Super Tomcat



Northrop Grumman F-14D Super Tomcat (Northrop Grumman)

processor. Litton AN/ASN-139 INS; Smiths AN/AYQ-15 stores management system. ECM equipment includes Goodyear AN/ALE-29 and AN/ALE-39 chaff and flare dispenser, with integral jammers

TARPS: By 1993 89 aircraft (23 F-14As, 11 F-14Bs, 55 F-14Ds) had been fitted to carry TARPS (tactical air reconnaissance pod system). The TARPS underbelly pod houses a CAI KS-87B frame camera, Fairchild KA-99 low-altitude panoramic camera, and Honeywell AN/AAD-5 infra-red linescan reconnaissance equipment

Weapons

All versions: 1 General Electric M61A-1 Vulcan 20 mm gun mounted in port-side forward fuselage (675 rounds ammunition). Four AIM-7 Sparrow air-to-air missiles mounted partially enclosed in underfuselage recesses, or 4 AIM-54 Phoenix missiles carried on special pallets attached to the bottom of the fuselage. 2 wing pylons, 1 under each fixed-wing section, can carry 4 AIM-9 Sidewinder missiles, or 2 additional Sparrow or Phoenix missiles with 2 Sidewinders

F-14A: All in-service F-14As have been given Tape 116 software enabling them to carry out full ground attack with conventional bombs

F-14D: F-14D has bombing capability with Rockeye and CBU-59 cluster bombs; GBU-16 LGB, Gator mine. (AGM-88 HARM and SLAM ASMs planned but not yet funded)

The F-14 employs wing 'oversweep' rather than wing-folding to reduce its footprint on the carrier flight deck and in the hangar (US Navy)

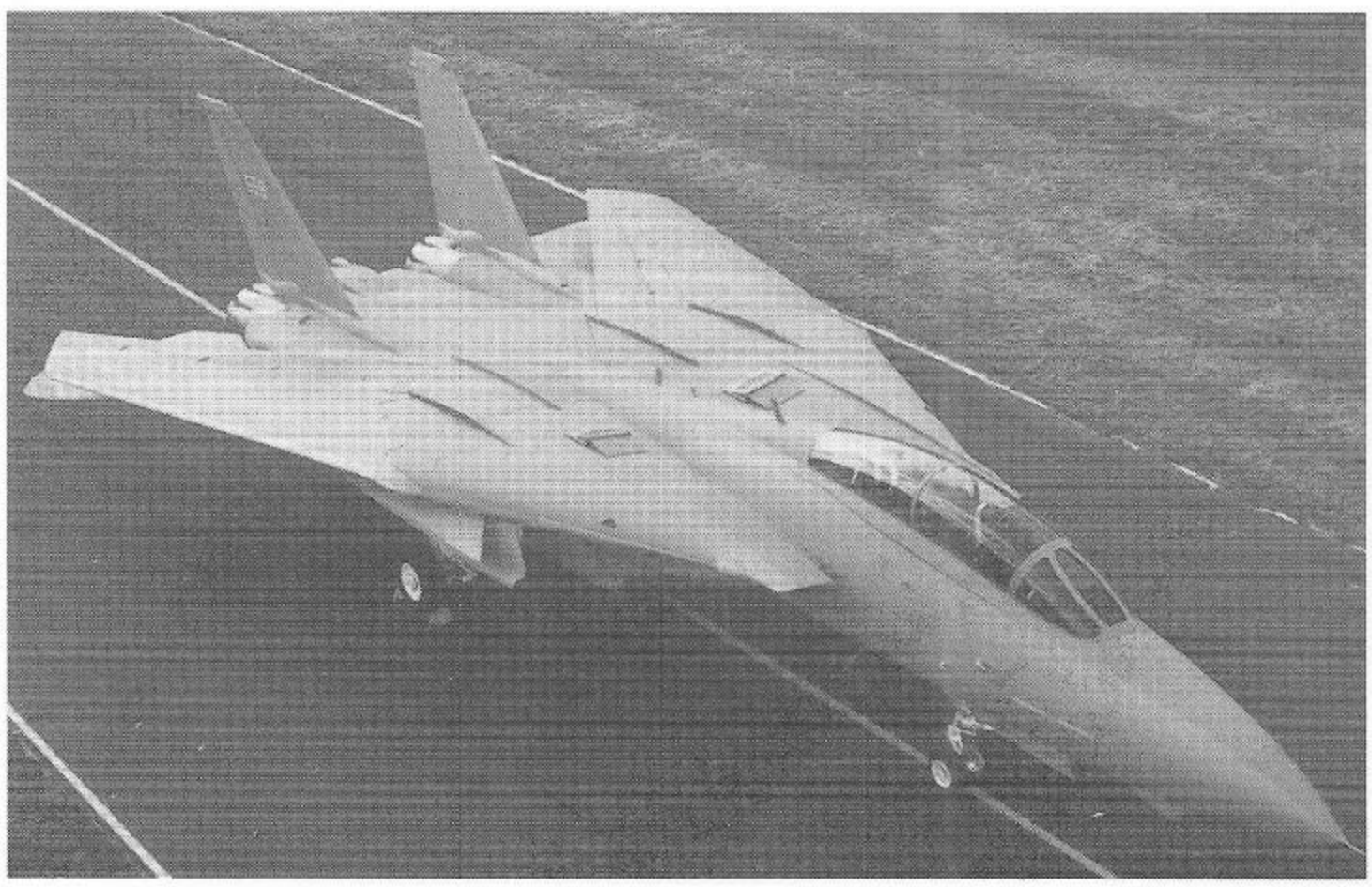
FURTHER INFORMATION

PROGRAMME

Design of the F-14 Tomcat began in the late 1960s, following the failure of the F-111B, and was intended to replace the McDonnell F-4 Phantom as the US Navy's carrierborne fleet air defence fighter. The first prototype flew in December 1970 and the first two F-14A squadrons became operational in October 1972, with the first carrier deployment in 1974. The F-14A suffered a number of problems, particularly with the original engines, but most of these were solved when the TF30-P-414A engines were installed. The F-14A also achieved the type's one export success, with 80 aircraft being ordered by Iran, which was then ruled by the Shah.

The F-14B entered service in 1988, the aircraft being a mix of 38 new builds and 32 reworked F-14As. The main development effort was, however, concentrated on the F-14D, although, in the event, only a relatively small number was produced.

The F-14 has already been in service for 22 years and the various marks are scheduled to remain with the US fleet for many years to come, although improvement programmes are in the pipeline. It remains, however, a highly effective air superiority fighter with a respectable, secondary ground-attack capability, and will certainly be more than a match for virtually all potential opponents for a long time yet.



F-14A (Plus) with its wings in the 'oversweep' position

NAVAL VARIANTS

F-14A: The initial and still by far the most numerous version of the F-14. 557 F-14As were delivered to the US Navy, of which 32 were reworked to F-14B and 18 to F-14D(R), and some 385 remain in service

F-14B: The F-14B is an improved F-14A incorporating GE F110-GE-400 turbofans, which necessitated a 1.27 m (4.17 ft) plug in the afterburner. Additional changes are NASA scoops for the Vulcan cannon, elimination of the glove vanes and modifications to the cockpit. 38 were produced as new-build aircraft and 32 were converted from F-14As. A further seven conversions have been funded in FY92 and 12 more in FY93

F-14A/B: A total of 196 aircraft, comprising all available F-14Bs plus the balance from late production F-14As

will be reworked from FY94 onwards, to fit them with some F-14D features, including AN/ALQ-67 RWR (not required by F-14B), chaff dispenser, AN/AYK-14 mission computer (plus interface to analogue 5400 computer), new tactical information display, and a MIL-STD-1553B digital databus. In addition, the airframe will be upgraded to give a 7,500 hour life

F-14D Super Tomcat: The F-14D is a yet further improved version with AN/APG-1 radar, NACES seats in NVG-compatible cockpits, twin IRST/TV pod, JTIDS link, AN/ALQ-67 RWR, plus an enhanced missile capability, enabling it to launch AIM-120 AMRAAM and AIM-54C Phoenix missiles. It was originally planned to produce 127 new-build aircraft, but this was cut back to 37. In addition, 18 F-18As were rebuilt as F-14D(R). The first F-14D flew in November 1987, with the first production aircraft leaving the factory in March 1990 and the last in July 1992. The first F-14D(R) was produced in September 1991 and the last in Spring 1993

Future upgrades

The core of the current US Navy fleet comprises 251 F-14D/D(R) and F-14A/B Upgrade, the balance of 132 being unmodified F-14As and Bs. It is planned to upgrade these 251 further by fitting a digital flight control system (FY96); GPS (from FY95, F-14Ds, first) AN/ARC-210 radios (from FY98) and improved mission recorders (from FY99). In addition, consideration is being given to installing laser designators, FLIR and AN/ALE-50 to offset the possible withdrawal of A-6 Intruders by 2000.

Iranian F-14A: The Iranian Air Force purchased 79 F-14As, which were delivered in 1976-78. These had a slightly different ECM outfit, but retained the Phoenix missile. Of the 79 supplied it is believed that about 25 remain in an airworthy state.

OPERATIONAL

F-14s form an integral part of all carrier air wings, with 20 in the 'power projection' and 14 in the '50 Tacair' wings. They normally operate on airborne patrols, with an E-2C Hawkeye stationed some 200 n miles (370 km) from the carrier group, which is the first to detect targets and then vectors the F-14s on to them. The F-14's combination of AIM-54 Phoenix (unique to this aircraft), AIM-7 Sparrow and AIM-9 Sidewinder give it a very powerful armoury. A proportion of the F-14 fleet is fitted to operate TARPS and it is usual for each carrier air wing to include three such aircraft. Since the issue of the appropriate Tape 116s to the F-14As all F-14s now have a conventional bombing capability.

DESIGN

The F-14 was designed at a time when swing-wings were fashionable and is one of the relatively few such designs to achieve operational success. The wing sweepback can be varied from a min of 20° to a max of 68°, although an 'oversweep' of 75° is used aboard ship to reduce the area occupied by the aircraft without having to resort to the engineering complexities involved in wing-folding mechanisms. The wing pivot point is 2.72 m (8.93 ft) from the aircraft centreline and the fixed glove has dihedral to minimise cross-sectional area and reduce wave drag. On the F-14A small canards known as 'glove vanes' extended forward progressively to 15° from inboard leading-edge to balance supersonic trim change and to unload tail surfaces, but these were eliminated from the F-14B onwards.

NORTHROP GRUMMAN (VOUGHT) F-8(FN) CRUSADER

AIRCRAFT

Role: Single-seat, supersonic, carrier-based fighter

In naval service: France (17)

SPECIFICATIONS

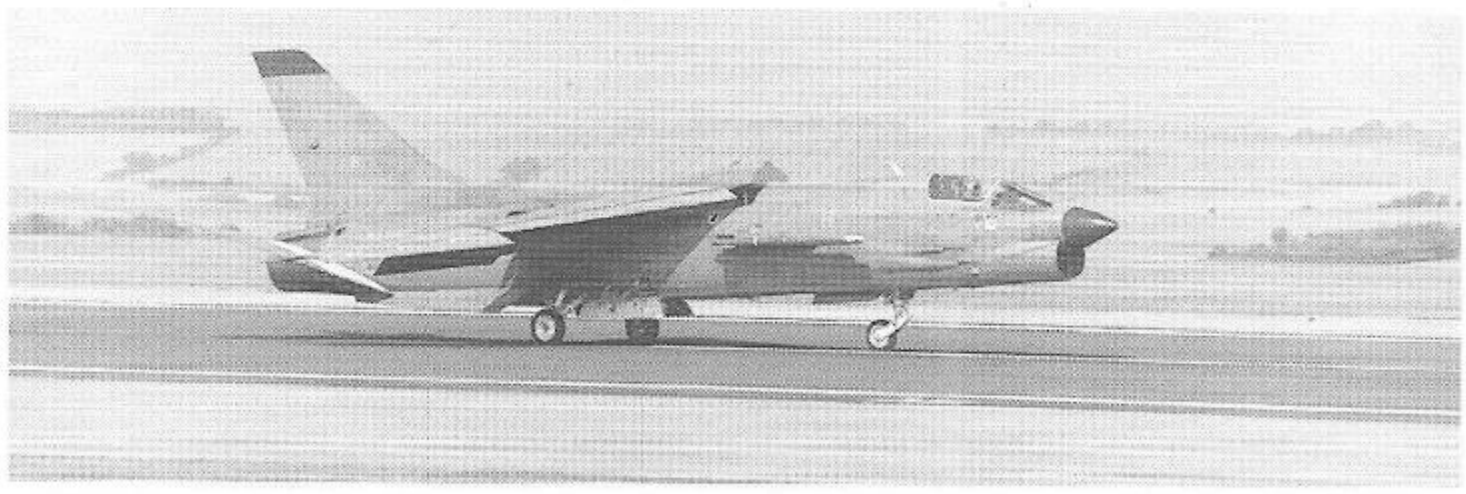
Dimensions
Wing span: 10.87 m (35.66 ft)
Width (wings folded): 6.86 m (22.5 ft)
Length, overall: 16.61 m (54.5 ft)
Height, overall: 4.80 m (15.75 ft)

Wheel track: 2.94 m (9.66 ft)
Wing area: 34.84 m² (375.0 sq ft)

Weights
Operating weight, empty: 8,960 kg (19,751 lb)
Max take-off weight: 15,420 kg (34,000 lb)
Max ordnance: 2,268 kg (5,000 lb)

Performance
Max level speed: Nearly Mach 2
Cruising speed at 12,190 m (40,000 ft): 486 kts (901 km/h)
Service ceiling: 15,240 m (50,000 ft)
Combat radius: 521 n miles (965 km)
Ferry range: 1,216 n miles (2,253 km)

Power plant: 1 Pratt & Whitney J57-P-20A turbojet, rated at 47.6 kN (10,700 lb st) and 80.07 kN (18,000 lb st) with afterburner
Fuel: Total internal fuel capacity 5,300 litres (1,398 US gallons)
Accommodation: 1 pilot on Martin-Baker Mk F7 lightweight ejection seat
Sensors: APQ-104; radar warning receiver (RWR)
Weapons: 4—20 mm Colt cannon in nose, with 84 rounds per gun; 2 AIM-9 Sidewinder AAM; MATRA R.500 Magic IR; or MATRA R.530 radar-guided weapon

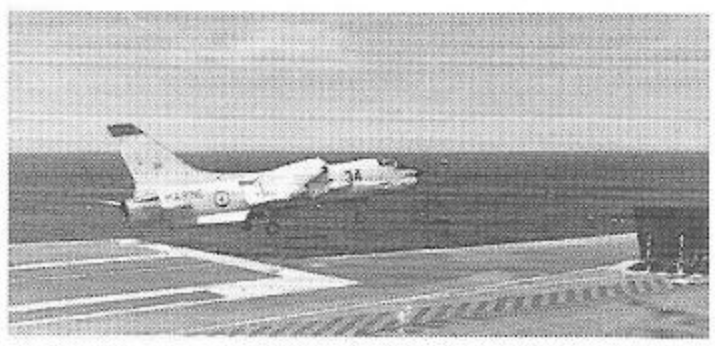


Vought F-8E(FN) lines up for take-off, showing its variable-incidence wing raised to the full 7° (Jane's/Paul Tompkins)

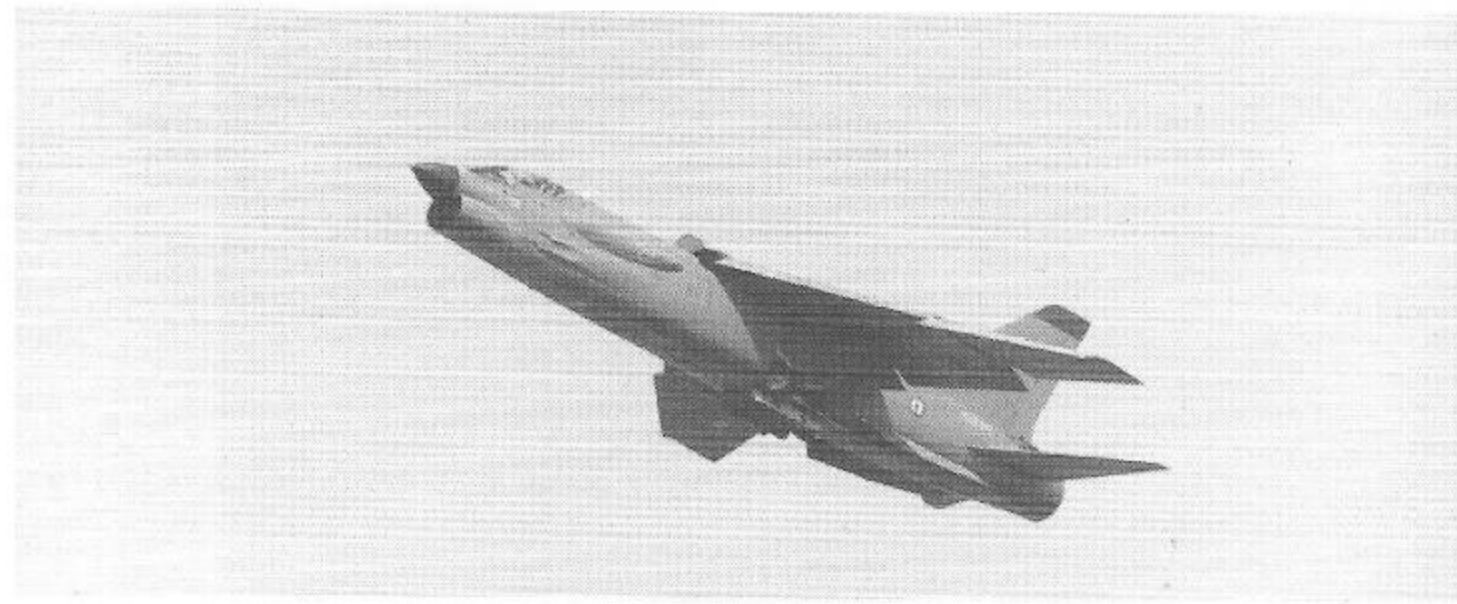
FURTHER INFORMATION

PROGRAMME

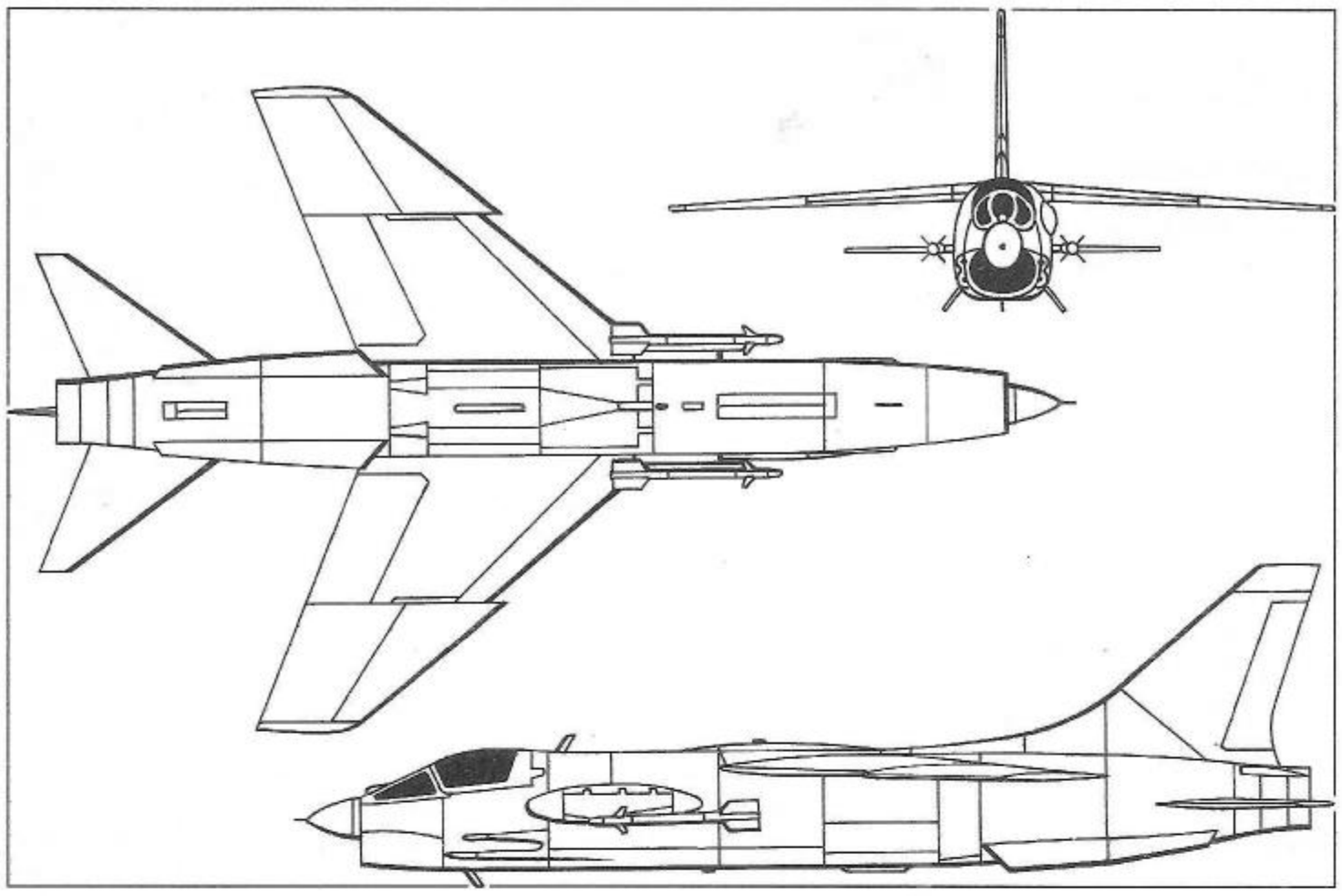
The prototype of the US Navy's XF8U-1 Crusader flew for the first time on 25 March 1955, during which it exceeded Mach 1 in level flight, a rare and exciting feat



F-8E(FN) launching from the carrier Clemenceau (ECP Armées)



The French Navy will continue to employ its 17 remaining F-8Es as fleet air defence fighters until the arrival of the Rafale M (Jane's/Paul Tompkins)



Northrop Grumman (Vought) F-8 (FN) Crusader (Jane's/Mike Keep)

at that time. A total of 1,261 was built for the US Navy and the aircraft was very highly regarded and popular with its pilots, giving excellent service in Vietnam.

Meanwhile, the French Navy had two new aircraft carriers, *Foch* and *Clemenceau*, coming into service and needed an air defence fighter to protect the carrier battle groups. No indigenous aircraft proved suitable, so, despite a distinct aversion at that time to procuring American equipment, the (then) Ling-Temco-Vought Crusader was selected, with an order for 42 being placed in August 1963. Designated F-8E(FN), the first production aircraft flew in June 1964 and the last (which was also the final new-build Crusader) in January 1965.

DESIGN

The most unusual feature of the Crusader's design is the variable-incidence wing which hinges upwards at an angle of 7° in order to give the pilot a good view when landing. But, even though the designers had taken such steps to improve landing capability, the Crusader still proved to be too fast for landing on the French carriers, *Foch* and *Clemenceau* and, when the F-8E was ordered, further steps had to be taken to improve performance. These included splitting the drooping wing leading-edges, the introduction of flap blowing (boundary layer control), doubling the aileron and flap deflection, a 2° reduction in wing incidence, and enlarged tail surfaces. All these measures reduced carrier approach speed by some 28 km/h (15 kts). Other changes included fitting APQ-104 radar to achieve compatibility with French Matra R-530 AAMs.

OPERATIONAL

All remaining Crusaders serve with 12ème Flotille (12 F) at Landivisiau, which provides seven aircraft for each of the two carriers when they are operational.

MODERNISATION

Most of the (then) existing F8-E(FN)s were fitted with new wings in the early 1970s. Several plans to replace the F-8E(FN) were then made and retirement dates set, only to be abandoned. One project in the mid-1980s, was to replace the aircraft with Super Etendards fitted with AAMs while a more recent plan was to retire the Crusaders on 30 June 1993, leasing F/A-18 Hornets from the US Navy to fill the gap until the Rafale M entered service, but this was turned down by the French Government.

As a result, the navy had to find a means of keeping the Crusader operational until 1998 and Dassault devised a plan to refurbish 17 of the remaining 19 aircraft, which was carried out at the naval workshops at Cuers between 1992 and 1995. Apart from fitting a new IR warning receiver, however, the work mainly involved safety, with priority being given to strengthening the airframe, replacing wiring, fitting new ejection seats, and updating the navigation system.

The Crusader is an aircraft with a fine history, but its air defence capability in the face of a threat from modern, well-equipped, land-based attack aircraft is very limited as its avionics are outdated, it lacks a look-down (pulse Doppler) radar and its missiles are old. As a result the Rafale M is eagerly awaited by the French Navy.

LOCKHEED MARTIN (LOCKHEED) S-3 VIKING

AIRCRAFT

Role: Carrierborne ASW aircraft

In naval service: USA (143)

SPECIFICATIONS

(S-3B)
Dimensions
Wing span:
wings extended: 20.93 m (68.66 ft)
wings folded: 8.99 m (29.5 ft)
Length:
overall: 16.26 m (53.33 ft)
tail folded: 15.06 m (49.41 ft)
Height:
overall: 5.06 m (16.60 ft)
tail folded: 4.65 m (15.25 ft)
Wheel track: 4.19 m (13.75 ft)
Wheelbase: 5.72 m (18.75 ft)
Gross wing area: 55.74 m² (600 sq ft) (approx)

Weights
Weight, empty: 10,954 kg (24,150 lb)
Max take-off weight: 21,592 kg (47,602 lb)
Max carrier-landing weight: 16,676 kg (36,766 lb)

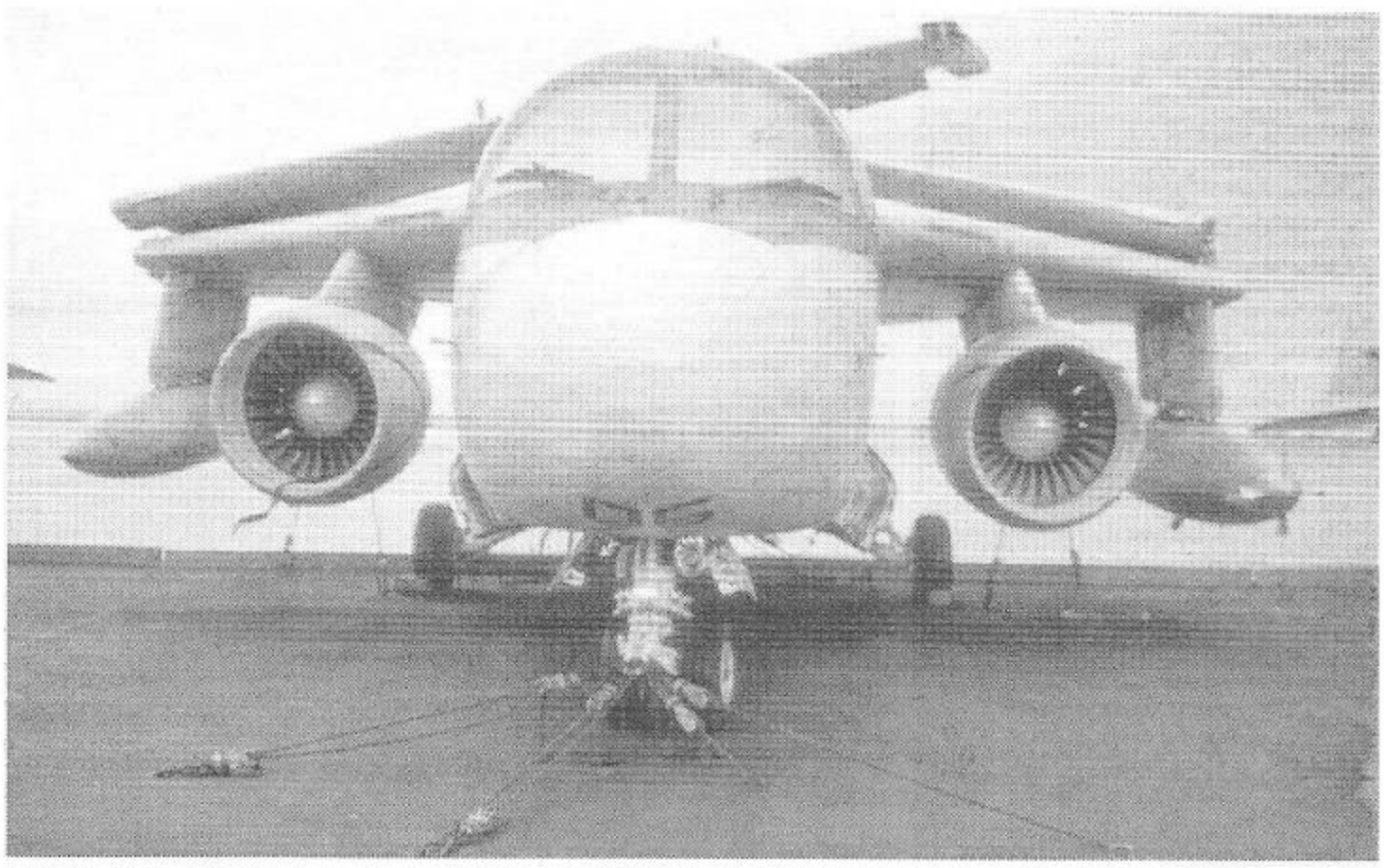
Performance
Max level speed at 6,100 m (20,000 ft): 450 kts (834 km/h)
Service ceiling: 12,200 m (40,000 ft)
Operational ceiling (with passengers): 10,670 m (35,000 ft)
Range with max payload: 2,000 n miles (3,706 km)
Ferry range: 3,230 n miles (6,085 km/h)

Lockheed S-3B Viking with Sargent-Fletcher refuelling pods (Paul Tompkins)

Power plant: 2 General Electric TF34-GE-2 high-bypass ratio turbofan engines, each rated at 41.25 kN (9,275 lb st)
Fuel: 7,192 litres (1,900 US gallons) (usable) in 2 integral wing tanks, plus 2—1,136 litres (300 US gallons) jettisonable tanks on underwing pylons

Accommodation: Pilot, co-pilot (also navigator), tactical co-ordinator, and sensor operator

Sensors (SH-3B)
Radio: Provision for GPS and JTIDS in future
Radar: Texas Instruments AN/APS-137(V)1 radar



incorporating inverse synthetic aperture radar (ISAR) techniques

ASW: AN/AYS-1 Proteus acoustic signal processor, modified Sanders AN/OL-320/AYS data processing memory group integrated with IBM AN/UYS-1; updated Honeywell AN/AYK-10A(V) air data computer, interfaced with Harpoon anti-ship missile and other new systems; Hazeltine AN/ARR-78 sonobuoy receiver system, AN/AQS-81 MAD

ESM: Improved ESM systems' modified Goodyear AN/ALE-39 chaff/flare dispensing system; IBM AN/ALR-76 ESM

Weapons

Internal: Weapon options include 4 Mk 46/50 torpedoes, 2 B57 nuclear depth charges; 4 Mk 82 254 kg (560 lb) bombs or 4 Mk 36 destructors

External: 6 Mk 82/86 bombs; 2 Mk 52/55/56 mines; 2 Mk 60 torpedoes; 2 AGM-84 Harpoon anti-ship missiles; or 6 LAY-10C/-68A/-69A rocket pods/SUU-44A rocket pods.

Lockheed S-3 demonstrates its wing-folding (US Navy)

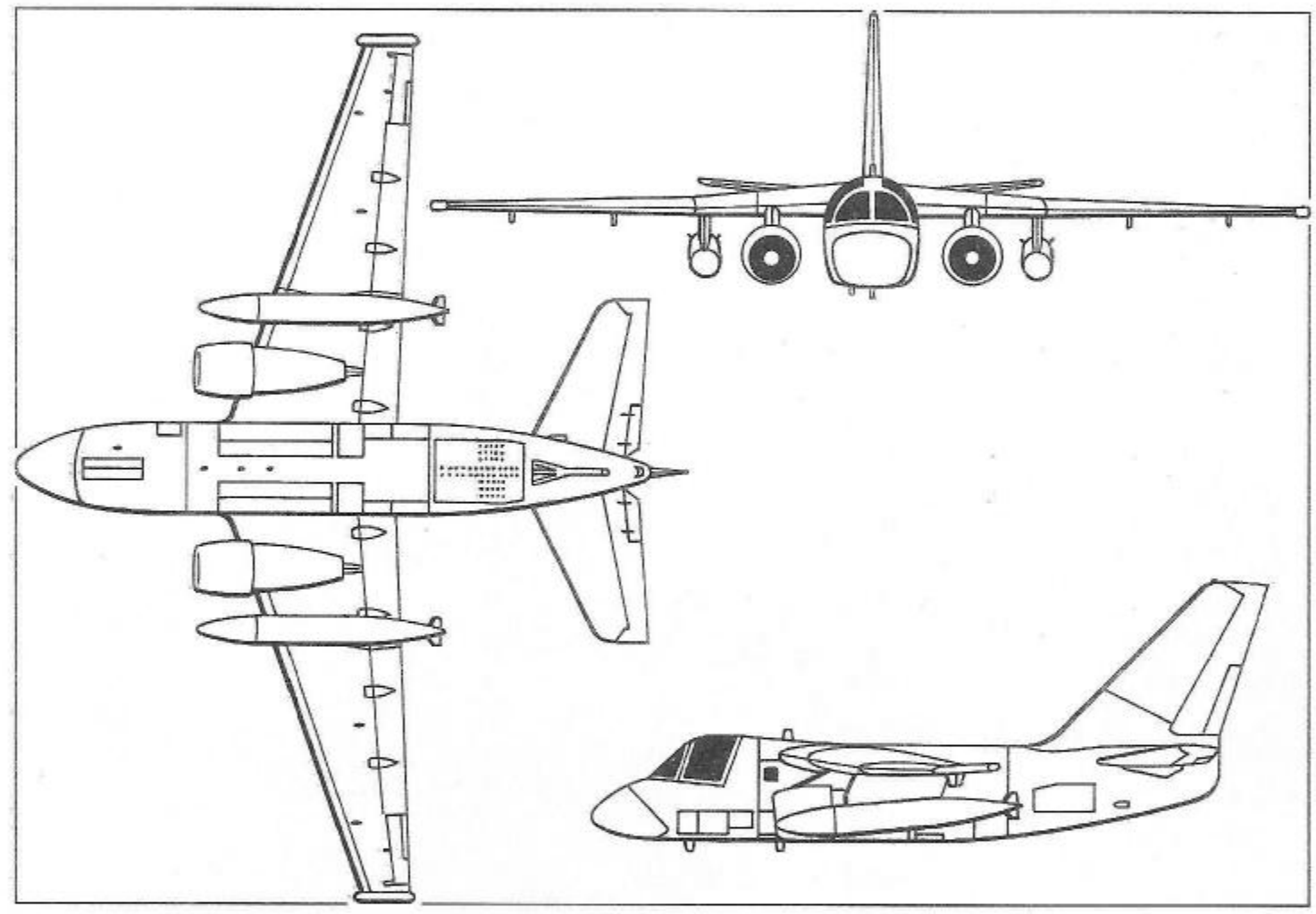
FURTHER INFORMATION

PROGRAMME

The Lockheed S-3 Viking was designed to replace the Grumman S-2 Tracker, with the first service delivery in 1973 and the 187th and last in 1978. No further examples have been built since that time, even though the production tooling has been retained against the possibility of further orders. In 1980 a contract was placed with Lockheed to develop an improved version — S-3B — and the in-service aircraft were upgraded to this new standard between 1986 and 1993.

Sixteen S-3As were converted for specialised electronic warfare tasks as ES-3As, in which they replaced the EA-3B Skywarrior. The only other service aircraft type is the US-3A transport aircraft. One S-3A was converted to the tanker role (KS-3A) but it was then decided that standard S-3A/Bs could be employed as tankers using 'buddy-packs' and the specialised tanker was not pursued further.

Lockheed Martin is currently working on a standard avionics suite for future upgrades of the P-3 Orion and S-3 Viking, which will have an open architecture for maximum flexibility and system growth.



Lockheed Martin (Lockheed) S-3 Viking (Jane's/Mike Keep)

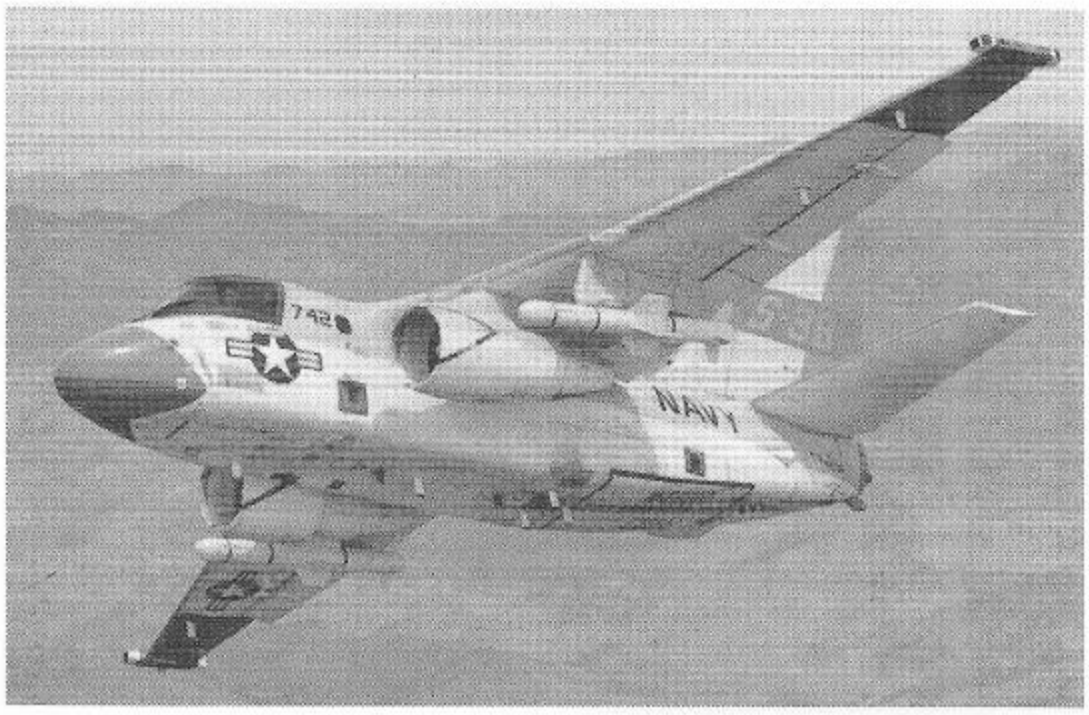
NAVAL VARIANTS

S-3A: This was the original production version of which 187 were produced, all for the US Navy.

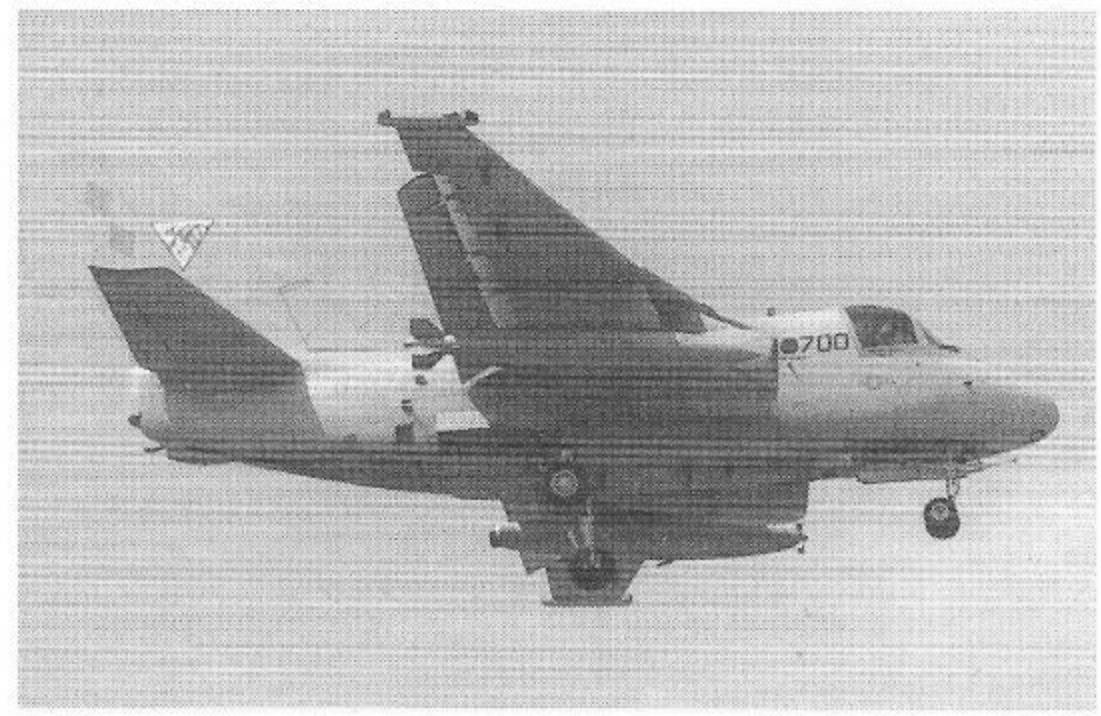
S-3B: The S-3B is an upgraded version of the S-3A with improved acoustic processing and ESM coverage, a new sonobuoy receiver, and the ability to launch AGM-84 Harpoon anti-ship missiles. Virtually all S-3As, apart from a few employed in training tasks, have been converted to S-3B standard.

US-3A: Six US-3As have been produced by modifying one of the prototypes and five early production S-3As. All ASW equipment has been removed to enable these aircraft to serve in the 'carrier on-board delivery' (COD) role, in which it serves alongside the turboprop-powered Grumman C-2A Greyhound.

ES-3A: A contract to develop an electronic reconnaissance version of the S-3A was let in 1988 and a modified S-3A airframe flew in 1991. Sixteen aircraft have been modified (one by Lockheed, the remainder at NAS Cecil Field) and equip two squadrons, which deploy a pair of these aircraft to each carrier air wing. The ES-3A carries a simplified version of the electronics fit of the EP-3A Aries II, which is installed in the weapons bay and rear fuselage, with some located in a dorsal pack above the wingroot. The equipment includes: AN/ALR-76 ESM; three AN/AYK-14 computers; MIL-STD-1553 databus; Navstar GPS; Omega navigation; Link 11 datalink; AN/APX-76 IFF interrogator; AN/APS-137 radar; OR-236 FLIR and an avionics cooling system.



Viking (US Navy)



Lockheed S-3B Viking of the US Navy (Paul Tompkins)

MCDONNELL DOUGLAS F/A-18 HORNET

AIRCRAFT

Role: Multipurpose strike/interdictor/fighter for carrierborne service. Some are also used for reconnaissance and others for EW support with ALQ-167 jammers

In naval service: US (1,015) Navy/USMC (there are also numerous land-based versions — see 'Further information')

SPECIFICATIONS

(F/A-18C)
Dimensions
Wing span: 11.43 m (37.5 ft)
Width, wings folded: 8.38 m (27.5 ft)
Length overall: 17.07 m (56.0 ft)
Height overall: 4.66 m (15.3 ft)
Tailplane span: 6.58 m (21.6 ft)
Wheel track: 3.11 m (10.2 ft)
Wheelbase: 5.42 m (17.8 ft)
Gross wing area: 37.16 m² (400.0 sq ft)

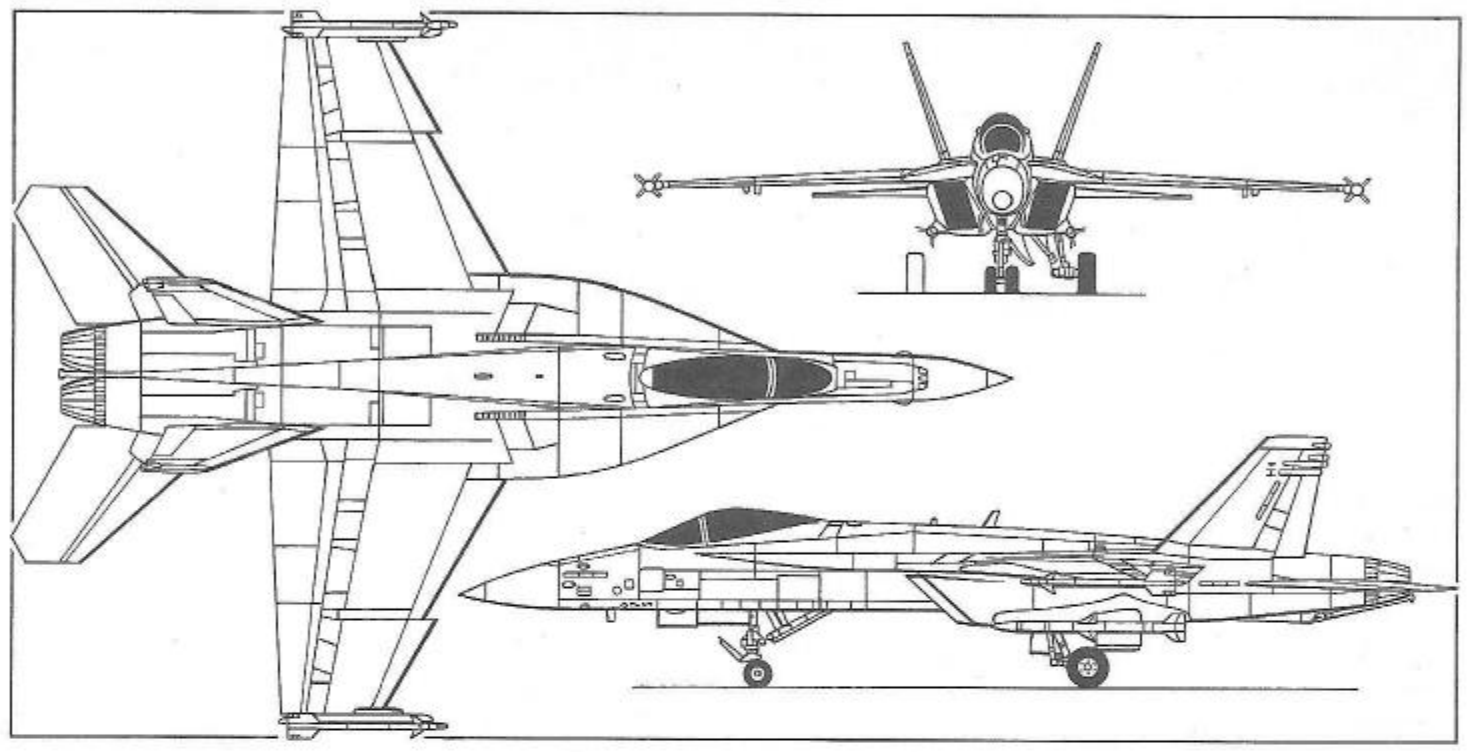
Weights
Empty: 10,810 kg (23,832 lb)
Max fuel (JP 5):
internal: 4,926 kg (10,860 lb)
external: 3,053 kg (6,732 lb)
Max external stores: 7,031 kg (15,500 lb)
Max take-off:
fighter mission: 16,651 kg (36,710 lb)
attack mission: 23,541 kg (51,900 lb)
max: 25,401 kg (56,000 lb) (approx)

Performance
Max level speed: Mach 1.8+
Acceleration from 460 kts (850 km/h) to 920 kts (1,705 km/h) at 10,670 m (35,000 ft): Under 2 min
Combat ceiling: 15,240 m (50,000 ft) (approx)
Take-off run: Under 427 m (1,400 ft)
Approach speed: 134 kts (248 km/h; 154 mph)
Min wind over deck:
launch: 35 kts (65 km/h)
recovery: 19 kts (35 km/h)
Combat radius, interdiction, hi-lo-lo-hi: 290 n miles (537 km)
Combat endurance, CAP 150 n miles (278 km) from aircraft carrier: 1 h 45 min
Ferry range, unrefuelled: 1,800 n miles (3,333 km)

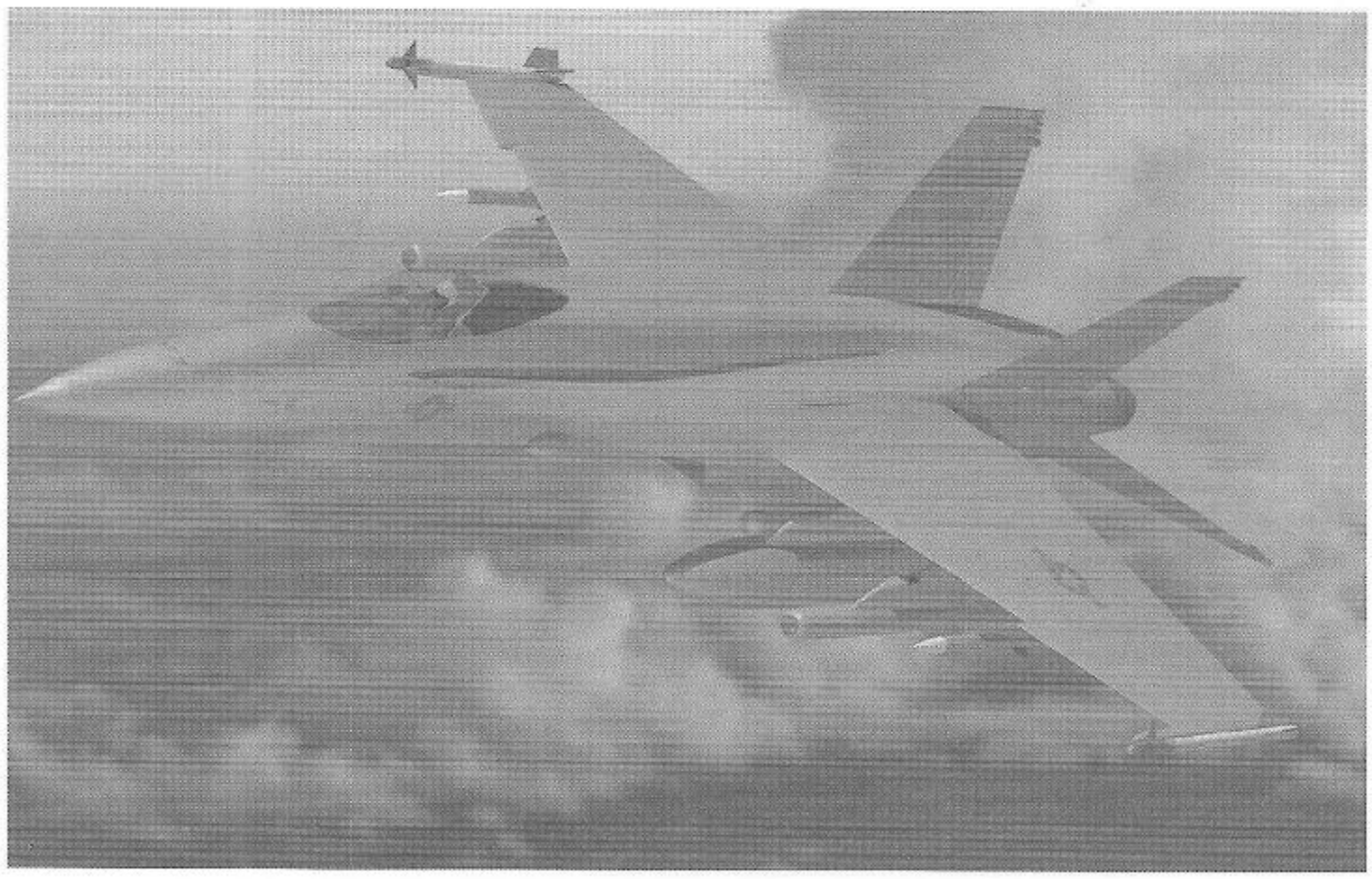
Accommodation
F/A-18A/C: Pilot only, on Martin-Baker SJU-5/6 zero/zero ejection seat
F/A-18B, F/A-18D (USN version): 2 pilots
F/A-18D (USMC version): Pilot and naval flight officer

Power plant
Pre-1992: 2 General Electric GE F404-GE-400 turbofans; 71.17 kN (16,000 lb st)
1992 and later: 2 General Electric F404-GE-402 EPE (Enhanced Performance Engine) low-bypass turbofans with afterburning; rated at approximately 78.3 kN (17,600 lb st)

Avionics
Communications: AN/ARC-182 UHF/VHF, Conrac communications system control
Radar: Hughes Aircraft AN/APG-73 multimode digital air-to-air and air-to-ground tracking radar
Flight: Automatic carrier landing system (ACLS) for all-weather carrier operations; Collins AN/ARN-118 Tacan, DF-301E UHF/DF, Eaton AN/ARA-63 receiver/decoder, JET ID-1791/A flight director indicator, Litton AN/ASN-130A inertial navigation system (plus GPS from FY93), being replaced by Litton AN/ASN-139 ring laser system (including retrofits); Night Attack F/A-18 has Hughes AN/AAR-50 thermal imaging navigation set (TINS)
Mission: 2 Control Data Corporation AN/AYK-14 digital computers, GEC-Marconi Type 117 laser designator,



McDonnell Douglas F/A-18 Hornet (Jane's/Dennis Punnett)



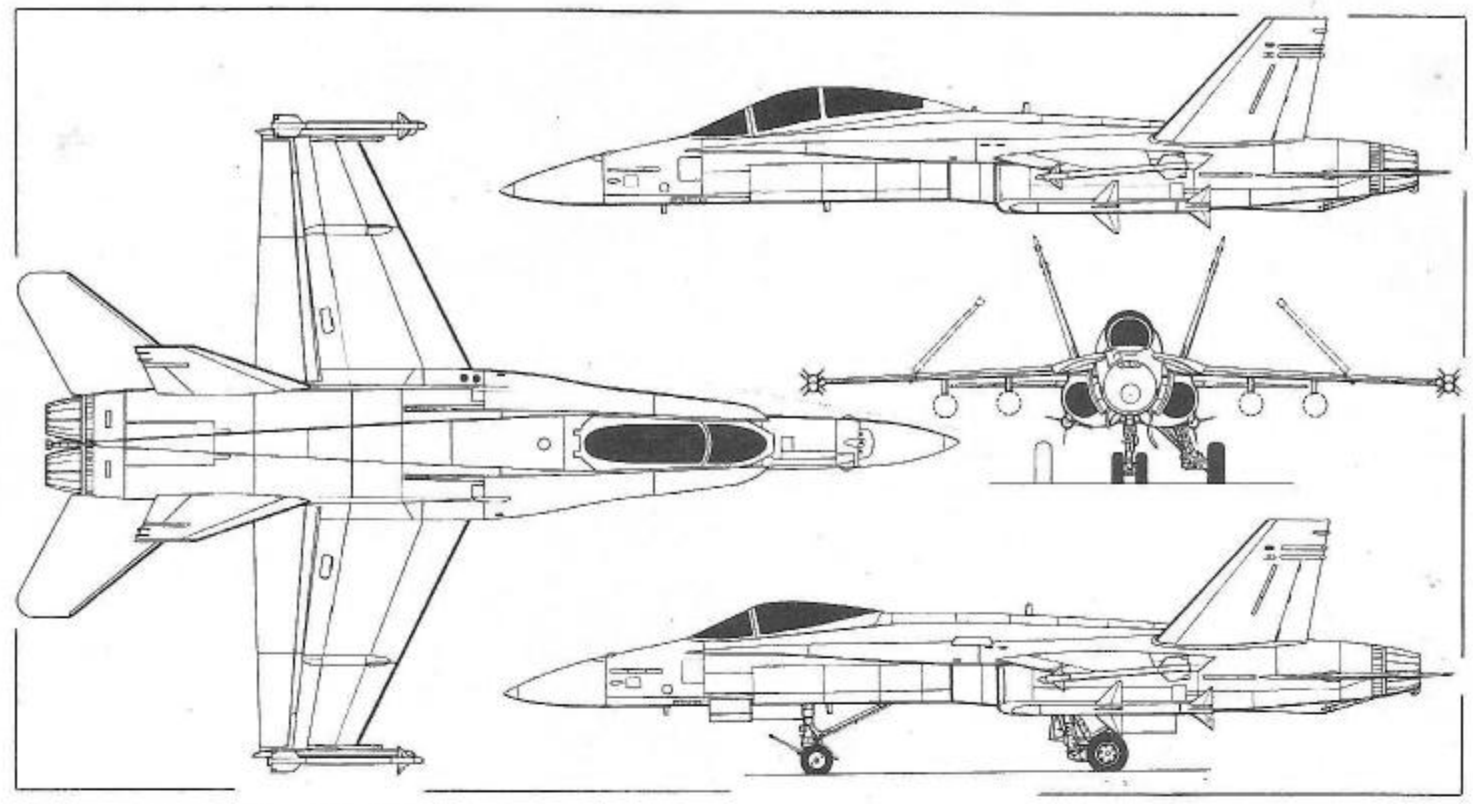
*Artist's impression of the projected McDonnell Douglas F/A-18 C²W Hornet for command and control warfare (*McDonnell Douglas)

F/A-18 of US Navy Squadron VFA-87 (Jane's/Paul Tompkins)

Harris AN/ASW-25 radio datalink and Loral AN/AAS-38 NITE Hawk targeting FLIR
Self-defence: Magnavox AN/ALR-50 RWR, Litton AN/ALR-67 RWR, Goodyear AN/ALE-47 chaff dispenser, Sanders AN/ALQ-126B deception jammers

Weapon stations
Wingtip stations: 2 (AIM-9 Sidewinder air-to-air missiles)
Outboard wing stations: 2 (air-to-air or air-to-ground weapons, including AIM-7 Sparrows, AIM-9 Sidewinders, AIM-120 AMRAAMs; AGM-84 Harpoons and AGM-65F Maverick missiles
Inboard wing stations: 2 (external fuel tanks, air-to-ground weapons or Brunswick ADM-141 TALD tactical air-launched decoys
Nacelle fuselage stations: 2 (Sparrows or Lockheed Martin AN/ASQ-173 laser spot tracker/strike camera (LST/SCAM) or AN/AAS-38 and AN/AAR-50 sensor pods
Centreline fuselage station: 1 (external fuel or weapons)

Weapons
Nuclear: B57, B61 tactical nuclear devices
Air-to-air: AIM-7 Sparrow; AIM-9 Sidewinder; AIM-120 AMRAAMs
Anti-ship: AGM-84 Harpoon
Anti-radar: AGM-88A HARM



McDonnell Douglas F/A-18D (Jane's/Dennis Punnett)

Air-to-surface guided missiles: AGM-65F Maverick; AGM-84E standoff land attack missile; AGM-62 Walleye EO guided-bomb
Air-to-ground gravity weapons: GBU-10 and -12 laser-guided bombs, Mk 82 and Mk 84 general purpose bombs, and CBU-59 cluster bombs
Gun: 1 nose-mounted M61A1 20 mm 6-barrel gun (570 rounds)

FURTHER INFORMATION

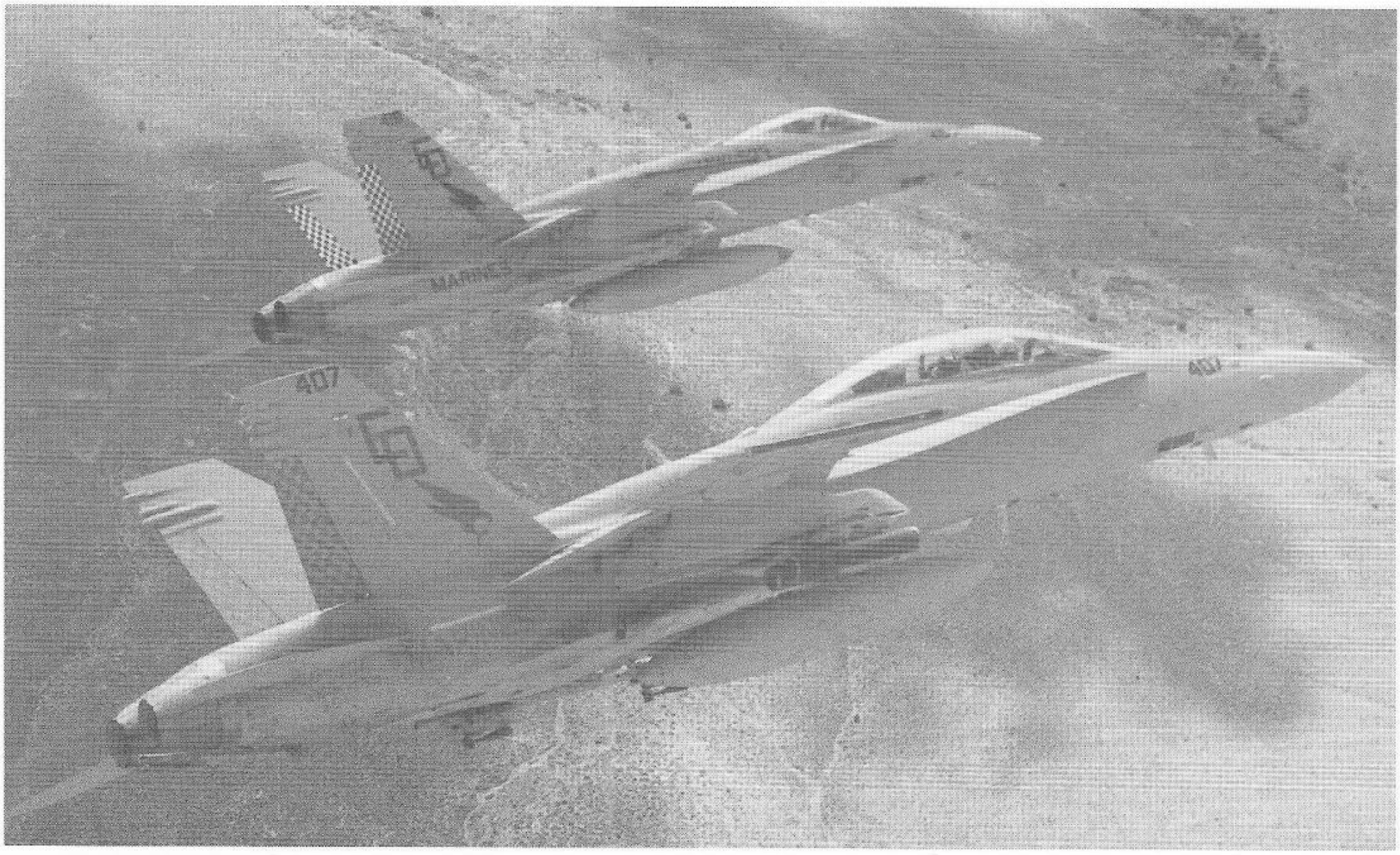
PROGRAMME

The F/A-18 replaced the A-4 Skyhawk and F-4 Phantom II and is now in the process of replacing the Grumman A-6 in US Navy and US Marine Corps service. This very successful programme has its origins in the US Navy's 1974 VFAX requirement for a new, smaller fighter to supplement the F-14 Tomcat, which resulted in the 1975 selection of a new aircraft developed from the Northrop YF-17. Initial plans were to produce two distinct versions: the F-18 fighter and A-18 strike attack but it was then decided to combine these two roles into one multipurpose airframe: the F/A-18. The first flight by an F/A-18 Hornet prototype took place on 18 November 1978 and all 11 preproduction aircraft were flying by March 1980. First deliveries of F/A-18A/B took place in May 1980 and were completed in 1987.

The F/A-18 has proved to be an outstanding success mainly because it is a true multipurpose aircraft. It is an excellent fighter, with good turning and dog-fighting capabilities, and a very capable strike/attack aircraft, being able to deliver a large amount of ordnance with great accuracy.

NAVAL VARIANTS

F/A-18A: Original production version was the single-seater F/A-18A, of which 371 were built.
F/A-18B: This is a 2-seater version of F/A-18A which was developed concurrently. This aircraft carried a second crew member and had a longer canopy, while carrying some 6 per cent less fuel. In all other respects it was identical to the single-seat version. 39 were built, but the type has never been issued to an operational unit.
F/A-18C: This is the current production model and, in essence, has improved avionics and is capable of carrying AIM-120 AMRAAM. The 138th and subsequent F/A-18Cs are night attack-capable aircraft, which have extra avionics and sensors to enable them to undertake night operations.
F/A-18D: The -D is a twin-seat version of the -C, with 31 of the baseline versions being produced before production switched to the night attack version, which has the same avionics and sensor enhancements as the F/A-18C
F/A-18D(RC). This is a version for the USMC, optimised for the reconnaissance role.
F/A-18E/F. These are single- and two-seat versions of



US Marine Corps F/A-18D (foreground) and F/A-18C, both belonging to Marine Corps squadron VMFA(AW)-533

an improved and stretched aircraft, with a greater landing weight, extra fuel, more powerful engines and two additional hardpoints. The first prototype was rolled out in 1995, the first production aircraft are due in FY97 and production will rapidly rise to 48 aircraft per year in FY98-FY01.

Foreign sales

In addition to the 1,015 currently in use or on order for shipboard use by the US Navy and USMC a large number of F/A-18s have also been sold, or are on order, for land-based use by: Australia — 75; Canada — 138; Finland — 64 (on order); Kuwait — 32; Malaysia — 8 (on order); Spain — 60 (plus 24 ex-USN F/A-18A ordered January 1995); Switzerland — 34 (on order)

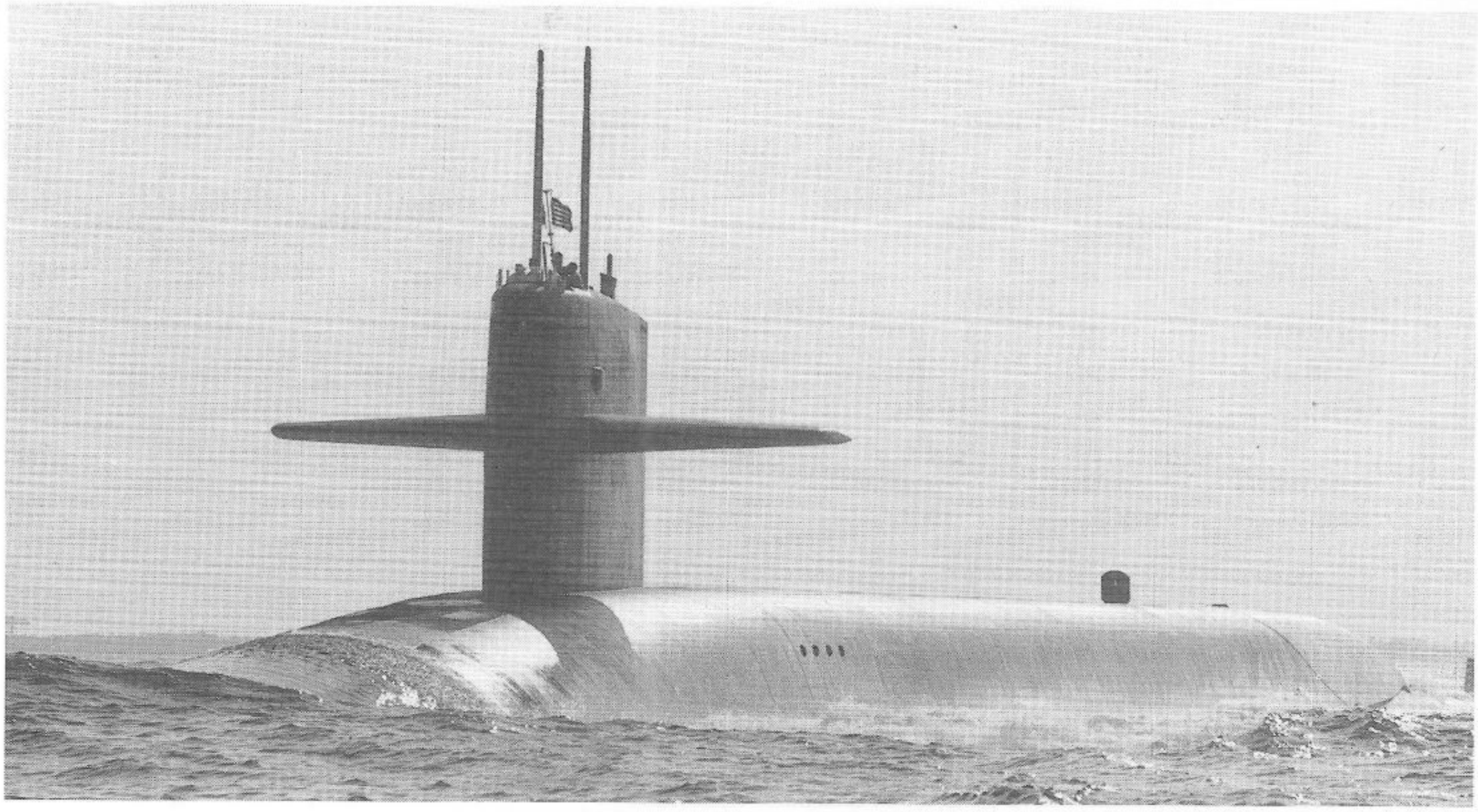
Service

As of mid-1996 the F/A-18 equipped 27 regular USN squadrons (plus the Blue Angels and four weapons centres), 17 regular US Marine Corps squadrons, four US Navy Reserve squadrons and four US Marine Corps reserve squadrons.

F/A-18D Night Attack Hornet of the US Marine Corps

STRATEGIC SUBMARINES, BALLISTIC MISSILE, NUCLEAR POWERED (SSBN)

INTRODUCTION



West Virginia *(SSBN 736) is armed with 24 Trident II (D5) missiles, each with a typical load of 10 MRV warheads* (Giorgio Arra)

For many years during the Cold War there was a strong emphasis on the 'strategic triad.' This was perceived as consisting of a land-based component of intercontinental ballistic missiles (ICBM); an airborne component (bombers); and a seaborne component of submarine-launched ballistic missiles (SLBMs) delivered by nuclear-powered, ballistic missile submarines (SSBN). It has gradually come to be realised, however, that the one element that meets all the criteria of range, reliability, stealth, availability and flexibility is the SSBN/SLBM combination.

One sign of this has been that while the strategic powers have been prepared to compromise, reduce and even eliminate bombers or ICBMs, they are not prepared to allow their SSBN/SLBM forces to be treated in the same way. Thus, bombers have been scrapped in large numbers as their lack of credibility has become obvious, while the vulnerability of ICBMs, whether static or land-mobile on trucks or trains, has made them of less value, as well; so, their numbers, too, have dramatically reduced. This should not, however, be seen as a triumph for navies so much as a realisation of the cold realities of global strategy.

China

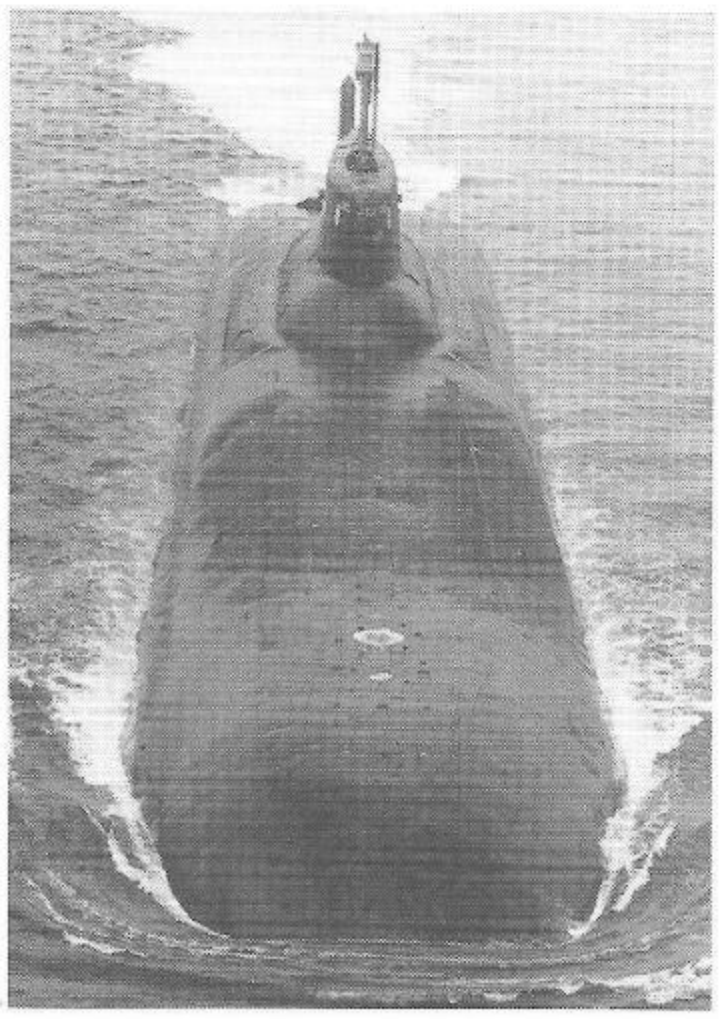
China, the most pragmatic of the strategic powers, is taking a long time to develop its SSBN/SLBM force to the same qualitative and quantitative status as the other four powers. But, for a country that takes a very long-term view on such matters, this is not a problem and at the present rate China should reach parity by early in the next century.

Development of the 'Daqingyu (Xia)' class SSBN and its associated SLBMs has been very slow, but must be seen in the context of a national scientific community that had little experience of nuclear matters and of a navy that did not possess even a single diesel-electric submarine before the late 1940s. Further, the Chinese received very little outside advice or assistance, apart from some very limited supplies of equipment from the Soviet Union prior to the rift between the two countries, and later some Western electronic equipment, mainly from France. In this light, the Daqingyu (Xia) programme must be judged a success.

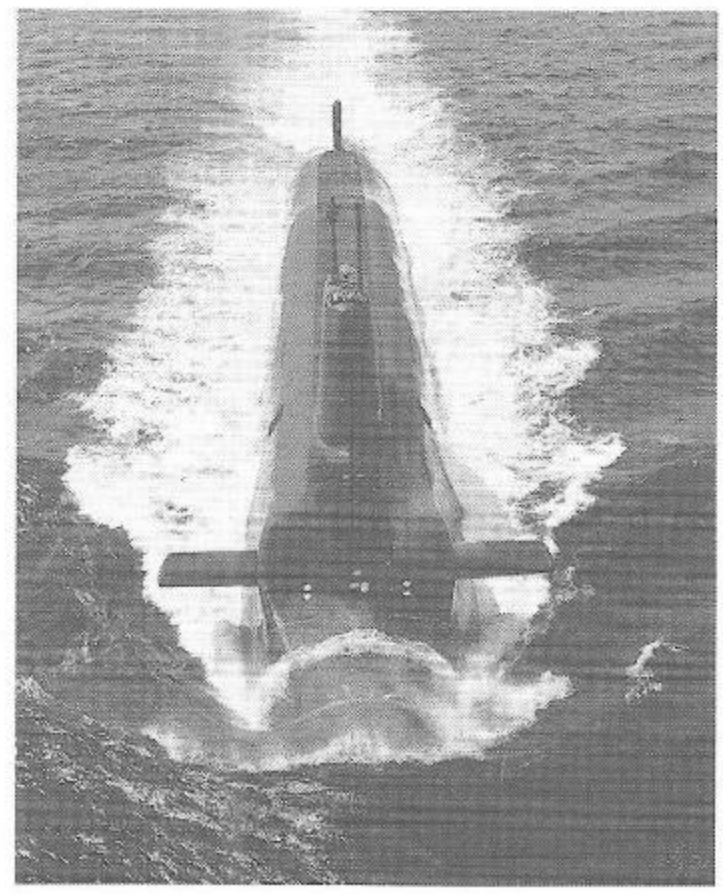
The next generation of Chinese SSBNs is now under construction and the JL-2 SLBM is well into development. Their impact on the Asian strategic balance will be immense and will be by no means insignificant on the global scene, either.

France

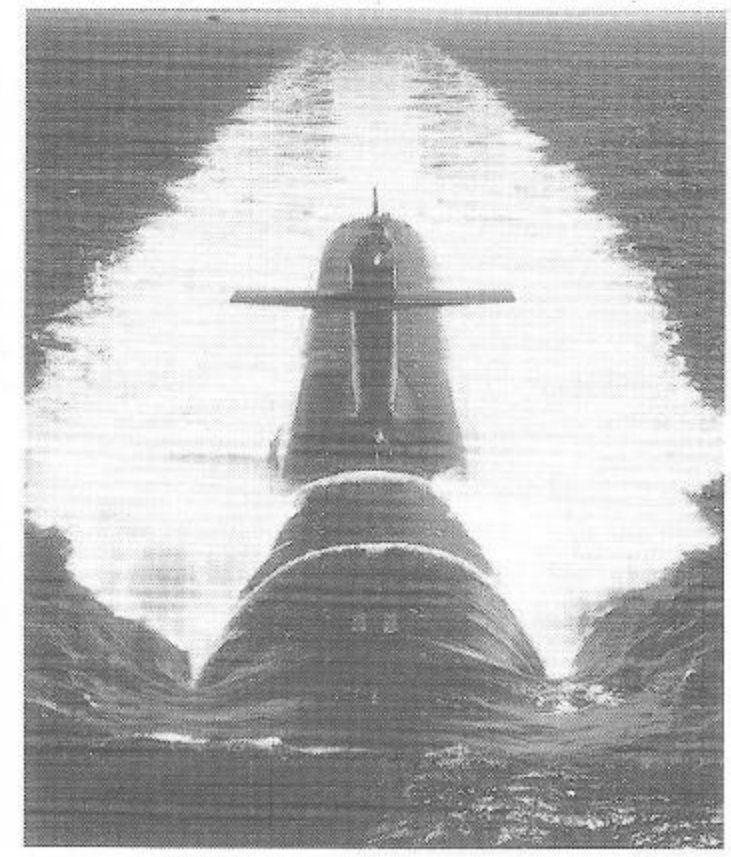
President Chirac's commitment to the French strategic force was demonstrated only too clearly by his determination to carry out the tests at Mururoa Atoll in 1995, despite almost universal criticism. Even so, he has



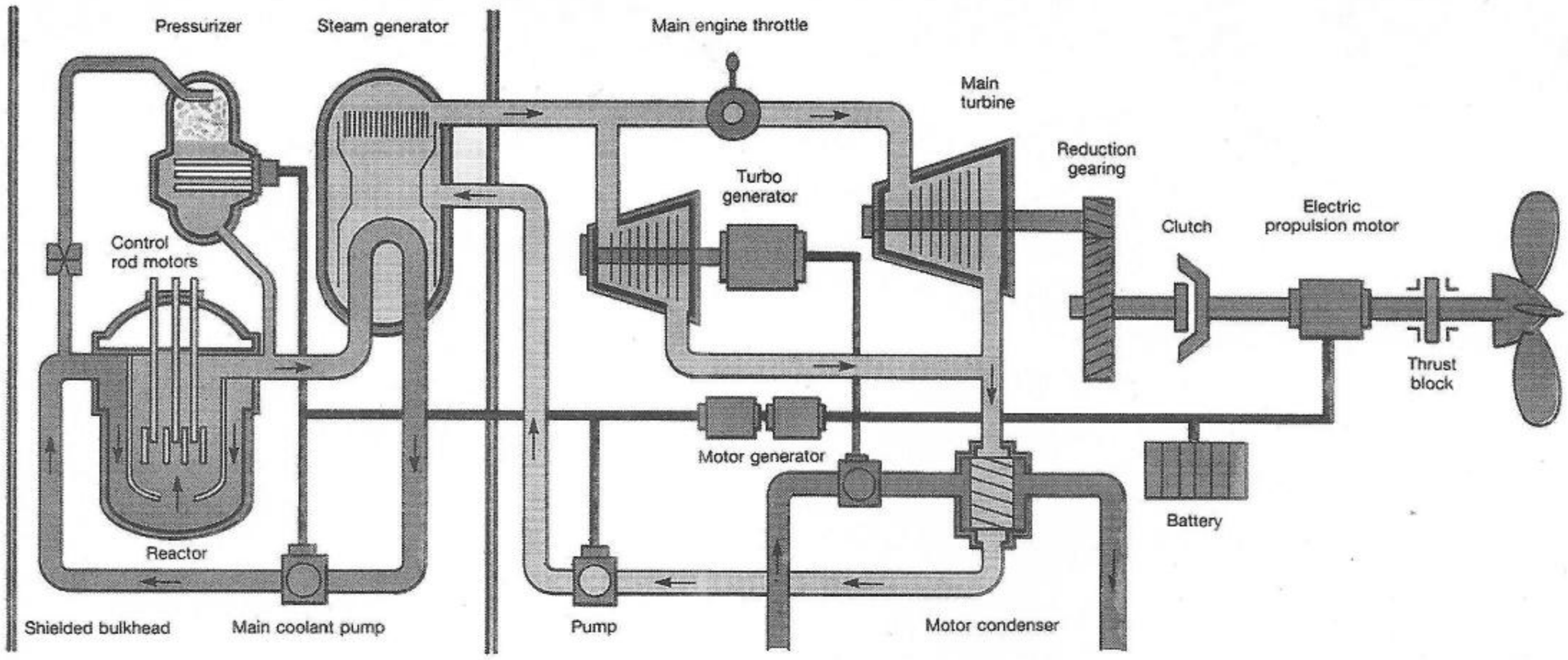
Russian 'Typhoon' class SSBN is unique in having its 20 SS-N-20 missiles mounted forward of the sail. All six are scheduled to undergo refits, indicating a life expectancy of at least another 10 years (UK MoD)



The British 'Vanguard' class has now replaced the 'Resolution' class although all four will not be in service until 1999. The short section forward of the tapered sail, the complex shape of the foredeck and the bow-mounted, non-retractable forward hydroplanes are unique to this British design. This is Victorious, *second in the class*



French SSBN, Le Triomphant, *entered service in 1996 and is entirely of French design and construction. The long bow, tall, parallel-sided sail, and sail-mounted forward hydroplanes are in marked contrast to its British contemporary, the 'Vanguard' class* (DGA/DCN)



The nuclear propulsion plant, which enables SSBNs to remain at sea for protracted periods (Jane's/IDR)

compelled the French defence structure to carry out a brutal examination of its projects and even the strategic forces have not escaped scrutiny. Thus, it was announced in January 1995 that the French air- and land-based strategic forces, consisting of Mirage IV bombers and 18 SSBS-3D land-based intermediate-range (2,175 n miles (3,500 km)) ballistic missiles will be phased out. That means that France will join the UK in having its nuclear deterrent force entirely submarine-based.

The French Navy's submarine deterrent force is undergoing a major upgrade with the fielding of the M45 SLBM and the introduction into service of the first of a totally new class of SSBN. There are five 'L'Inflexible' class in service, of which the four older ships, originally called the 'Le Redoutable' class, have been brought up to the standard of the newest ship. These will be replaced gradually by the 'Le Triomphant' class, with the nameship having replaced *Le Terrible* in September 1996 and the next two scheduled to enter service in 1999 and 2002, respectively. All French SSBNs will be armed with M5 SLBMs in due course.

Russia

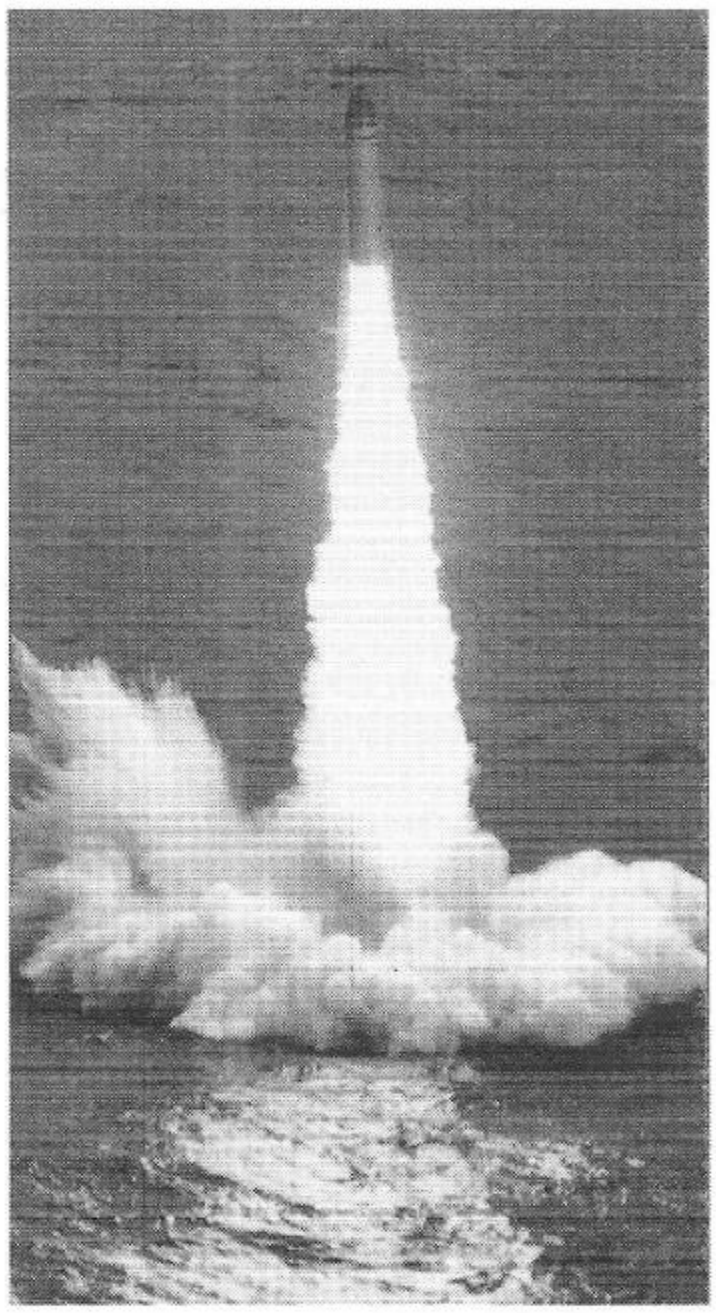
The construction of Delta IV and Typhoon SSBNs has now ended and it is expected that the Russian Navy will, in future, aim to operate a force of about 25 SSBNs, with replacements on a one-for-one basis to maintain that number.

Eighteen Delta Is were built, but the numbers are now reducing rapidly: one was paid off in 1992; three in 1993; six in 1994, and one in 1995. Similarly, the four Delta IIs are being phased out of service; one in 1994 and the remainder by 1998 at the latest. Of the 14 Delta IIIs, one has been converted to another role, but at least some of the remainder have been converted to take the newer SS-N-23 missile, suggesting a continuing requirement. There can be little doubt, however, that for the next 10 years or so, the strength of the force will lie in its Delta IVs and Typhoons. There are seven Delta IVs which entered service between 1985 and 1992, making them comparatively up-to-date, and there are six Typhoons, which have begun a refit process, showing that they are to be retained in service for at least another decade. Thus, if the Russian aim is to maintain a force of 25 SSBNs, it appears that the core force for the next decade will comprise:

Typhoon — 6
Delta IV — 7
Delta III — 12

In interpreting these figures, it should be noted that, even without the current financial pressures, the Russian Navy has traditionally maintained a far smaller proportion of its SSBN fleet at sea than France, UK or the USA. Thus, the figures should be reduced by at least 60 per cent to indicate numbers actually at sea.

A new class of SSBN is under development and there would appear to be no need for it to enter service until all the remaining Delta I and Delta II submarines have paid off. However, at least two types of new ballistic missile are being developed and may be retrofitted to existing classes.



The French M4 missile. Like Russia, the UK and US, France is discarding its land- and air-based strategic nuclear forces, leaving the submarine force as the ultimate deterrent

It would appear that, despite criticism of the design from the West, the continued development of the 'Delta' class shows that the Russian Navy has found the basic Delta design to be satisfactory for its needs. It comes as no surprise, therefore, that reports indicate that the new SSBN, now under development, is a new Delta variant, possibly called Type 935 by the Russians and Delta V in the West.

United Kingdom

The UK is well on the way to completing its new fleet of four 'Vanguard' class SSBNs, each armed with 16 US-made Trident II (D5) SLBMs. The UK Air Force has no strategic missiles and its only remaining tactical nuclear weapon, the WE 177 gravity bomb, is being retired in the next few years, leaving it as a tactical force, with the country's strategic role totally a naval responsibility.

In theory, each of the sixteen missiles could carry ten warheads, but the British Government has reduced this in two ways. First, it declared a voluntary overall limit of 96 re-entry bodies, but it has subsequently decided that a proportion of the missiles will carry a single warhead in a 'sub-strategic' role. This suggests a possible loading might be eleven missiles with eight re-entry bodies each, plus five missiles with single warheads.

The present force of 'Vanguard' class SSBNs is likely to stay in service at least until the 2020s and it is too early to say whether the British will either need or be able to afford an independent nuclear deterrent by that time, or, indeed, that the United States will still be prepared to transfer submarine and missile technology in the same way that it has done over the past 30 years. Thus, it would appear sensible, in view of the closer European integration likely to prevail by then, that the French and British deterrent forces should be combined, either as a European force, or as an Anglo/French force operated on behalf of the rest of Europe.

United States

With the phasing out of the last of the earlier classes, the US Navy's SSBN force is now composed entirely of Trident-armed 'Ohio' class submarines. This submarine force also provides the principle US strategic deterrent, the land- and air-based components having been sharply reduced since 1991. The whole force comes under the US Strategic Command Headquarters at Offut Air Force Base, Nebraska. Submarines are essentially in constant communication, and speed of response is equivalent to that of ground-based silos. Trident missile accuracy is as good as ground-based systems. Greater accuracy is being researched using GPS hardware, as are conventional kinetic energy warheads. These ships are, however, divided into two distinct groups, the first eight to be built being armed with Trident I (C4) missiles and the remaining ten having the more accurate, more powerful and longer-ranged Trident II (D5).

Under Strategic Arms Reduction Treaty (START) the number of re-entry bodies (RBs) attributed to each SSBN launch tube associated with the Trident I (C4) and Trident II (D5) missiles is limited to eight, most of which will be the 100 kT (W-76) warheads.

For the future, there will inevitably be a replacement for the 'Ohio' class in due course. It is difficult to predict what form this might take, although among the possibilities could be a repeat of the *George Washington* story, with the next SSBN being simply a stretched version of the 'New SSN' (NSSN) with a missile compartment dropped into a cut hull. Another factor may well be the number of missiles.

Numbers of Missiles

The question of the optimum number of SLBMs to mount in one SSBN hull is interesting. The first-ever SSBNs, the US Navy's 'Ethan Allen' class had to be produced rapidly and this was achieved by slicing the Scorpion SSN design abaft the sail and inserting a 'plug' to house the missile section. At the time, the US Navy carried out numerous studies to help decide just how many tubes were needed. Hydrodynamic and marine engineering aspects, firing rate and systems risks were examined, and cost/benefit analyses carried out. These led to the conclusion that no single figure represented the optimum, but that there was a 'plateau' ranging from a minimum of 12 to a maximum of 32 missiles. It was felt among the submarine community, however, that although higher numbers of tubes (and thus an ever longer submarine) were technically feasible and acceptable in all other respects, nevertheless, a 33.5 m (110 ft) plug, housing 16 missile tubes, was the maximum that the highest echelons of the naval leadership would accept.

This figure of 16 quickly became the 'norm' and the British and French navies both built their submarines with that number of tubes (and continue to do so) while the Russian 'Yankee-I' and 'Delta-II', and the Chinese 'Xia' classes were regarded with some disdain when they appeared with 'only' 12 tubes. In fact, 16 has continued to be the 'norm' although both the Russian and US navies have produced submarines with a greater number, the 'Typhoon' class having 20 and the 'Ohio' class 24 tubes.

It can, however, be argued that the new strategic environment requires a less heavy nuclear attack. Further, the new missiles are far more efficient, reliable and effective than earlier systems, while their warheads are not only far more numerous, but are also more powerful and more accurate. There thus appears to be no strong reason why the number of tubes in the next generation of SSBNs (of any navy) should not be reduced to 12, which would result in smaller and possibly cheaper submarines.

TABLE 1: SUBMARINE-LAUNCHED BALLISTIC MISSILES IN SERVICE — 1997

Missile		**CSS-N-3**	**M4**	**SS-N-6 Mod 2**	**SS-N-8 Mod 1**	**SS-N-18**
National type		JL-1	MSBS M4	RSM-25	RSM-40	RSM-50
Country		China	France	Russia	Russia	Russia
Dimensions	**Length** **Diameter**	10.7 m (35.1 ft) 1.4 m (4.59 ft)	11.05 m (36.25 ft) 1.93 m (6.33 ft)	9.65 m (31.66 ft) 1.5 m (4.92 ft)	14.2 m (46.59 ft) 1.8 m (5.9 ft)	15.60 m (51.18 ft) 1.8 m (5.9 ft)
Range		917 n miles (1,700 km)	2,160 n miles (4,000 km)	1,296 n miles (2,400 km)	4,212 n miles (7,800 km)	3,510 n miles (6,500 km)
Launch weight		14,700 kg (32,340 lb)	35,000 kg (77,161 lb)	14,200 kg (31,305 lb)	33,300 kg (73,413 lb)	35,300 kg (77,821 lb)
Throw weight		600 kg (1,320 lb)	1,200 kg (2,646 lb)	900 kg (1,984 lb)	1,150 kg (2,535 lb)	1,650 kg (3,638 lb)
Propulsion	**Stages** **Fuel**	two solid	three solid	two liquid	two liquid	two liquid
Guidance		Inertial	Inertial, mid-course update		Inertial, stellar update	Inertial, stellar update
Warheads (Note 1)	**Number** **Yield** **Type**	1 250 kT -	6 150 kT MRV[2]	1 1 MT -	1 1 MT -	3 200 kT MIRV
CEP		n/k	<185 m (607 ft)	n/k	0.22 n miles (400 m)	900 m
In service		1983	1985	1967	1971	1977

Missile		**SS-N-20**	**SS-N-23**	**Trident I (C4)**	**Trident II (D5)**
National type		RSM-52	RSM-54	UGM-96	UGM-133
Country		Russia	Russia	USA	USA
Dimensions	**Length** **Diameter**	18.0 m (59.05 ft) 2.4 m (7.87 ft)	16.8 m (55.12 ft) 1.9 m (6.23 ft)	10.39 m (34.09 ft) 1.88 m (6.16 ft)	13.42 m (44.03 ft) 2.11 m (6.92 ft)
Range		4,500 n miles (8,300 km)	4,481 n miles (8,300 km)	4,000 n miles (7,400 km)	6,480 n miles (12,000 km)
Weights	**Launch weight** **Throw weight**	84,000 kg (185,185 lb) 2,500 kg (5,511 lb)	40,300 kg (88,845 lb) 2,800 kg (6,173 lb)	32,850 kg (72,420 lb) 1,500 kg (3,307 lb)	59,090 kg (130,268 lb) 1,500 kg (3,307 lb)
Propulsion	**Stages** **Fuel**	three solid	three liquid	three solid	three solid
Guidance		inertial plus stellar update	inertial plus stellar update	Inertial, stellar update	Inertial, stellar update
Warheads	**Number**	10	4	8	8
(Note 1)	**Yield** **Type**	100 kT MIRV	100 kT MIRV	100 kT MIRV	100 kT or 475 kT MIRV
CEP		0.27 n miles (500 m)	0.27 n miles (500 m)	0.25 n miles (400 m)	0.065 n miles (122 m)
Entered Service		1982	1986	1984	1990

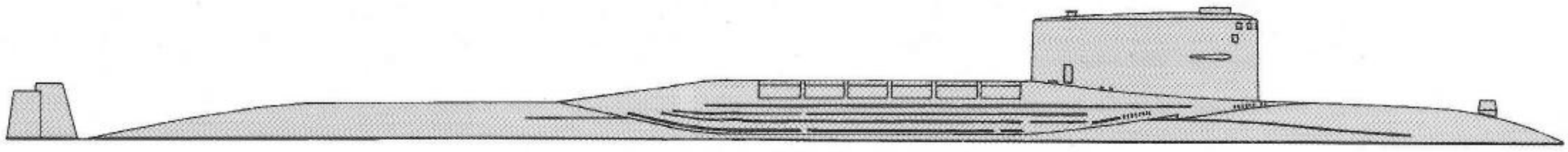
Note

1. Number of re-entry vehicles varied with range required and missile mission. Number shown is average.
2. Limited MIRV capability.

TABLE 2: SSBN FLEETS: 1 JANUARY 1997								
	SSBN					SLBM		
	Class	**Number built**	**Number in service 1997**	**Year entered service**	**Displacement (submerged) (t)**	**Type**	**Number of tubes**	**Warheads per missile**
China	Xia	1 (+1?)	1	1988	7,000	JL-1 (CSS-N-3)	12	1 × 250 kT
France	L'Inflexible	6	4	1974	8,920	M45	16	6 × 100 kT MRV[3]
	Le Triomphant	1 (+3)	1	1996	14,335	M45	16	6 × 100 kT MRV[3]
Russia	Delta I[2]	16	7	1973	10,200	SS-N-8	12	1 × 1 MT or 2 × 800 kT MRV
	Delta II[2]	4	3	1976	11,750	SS-N-8	16	1 × 1 MT or 2 × 800 kT MRV
	Delta III	14	13	1977	13,250	SS-N-18 SS-N-23	16 16	3 × 200 kT MIRV 4 × 100 kT MIRV
	Delta IV	7	7	1985	13,500	SS-N-23	16	4 × 100 kT MIRV
	Typhoon	6	6	1981	26,500	SS-N-20	20	10 × 100 kT MIRV
UK	Vanguard	2 (+2)	2	1995	15,850	Trident II (D5)	16	8 × 100 kT MIRV[1]
USA	Ohio	8	8	1981	18,750	Trident I (C4)	24	8 × 100 kT MIRV
	Ohio	9 (+1)	9	1988	18,750	Trident II (D5)	24	4 × 475 kT MIRV or 8 × 100 kT

Note:
1. The UK Government has stated that the total number of re-entry bodies in any one SSBN will not exceed 96.
2. These may be out of service by 1997.
3. May also have limited MIRV capability.

DAQINGYU (XIA)



Daqingyu (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: China, People's Republic

Class: DAQINGYU (XIA) (Type 092)

Built: 1 (+1?)
Active: 1

Building: 0
Proposed: 0

Displacement, submerged: 6,500 t
Length: 120 m (393.6 ft)
Beam: 10 m (33 ft)
Draught: 8 m (26.2 ft)

Speed, submerged: 22 kts
Diving depth: 300 m (985 ft)

Complement: 140

SUBMARINES

XIA (406)

Builder	Huludao Shipyard, China	**Launched**	30 Apr 1981
Laid down	1978	**Commissioned**	1987

WEAPONS SYSTEMS

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBM)

Ju Lang-1 (JL-1)

Twelve JL-1, two-stage, solid fuel, ballistic missiles, known under the NATO system as CSS-N-3.

Specifications
Length: 10.7 m (35.1 ft)
Diameter: 1.4 m (4.6 ft)
Guidance: inertial

Weight: 14,700 kg (32,340 lb)
Throw weight: 600 kg (1,320 lb)
Range: 4,320 n miles (8,000 km)
Re-entry vehicles: 1 single 250 kT; or 3/4 MIRV, each 90 kT
Accuracy — circular error probable (cep): n/k

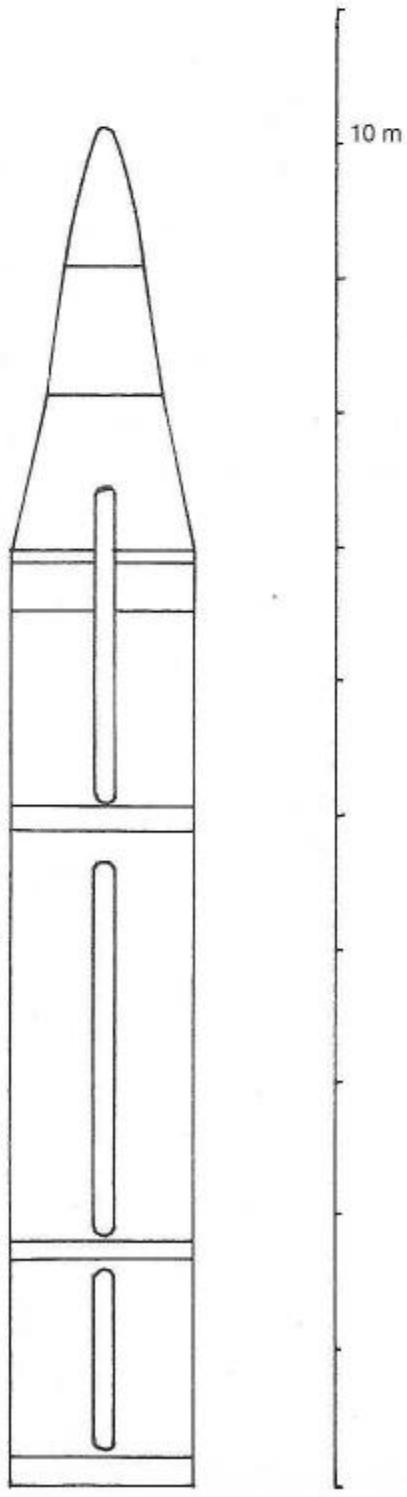
TUBES

Six 533 mm (21 in) bow tubes.

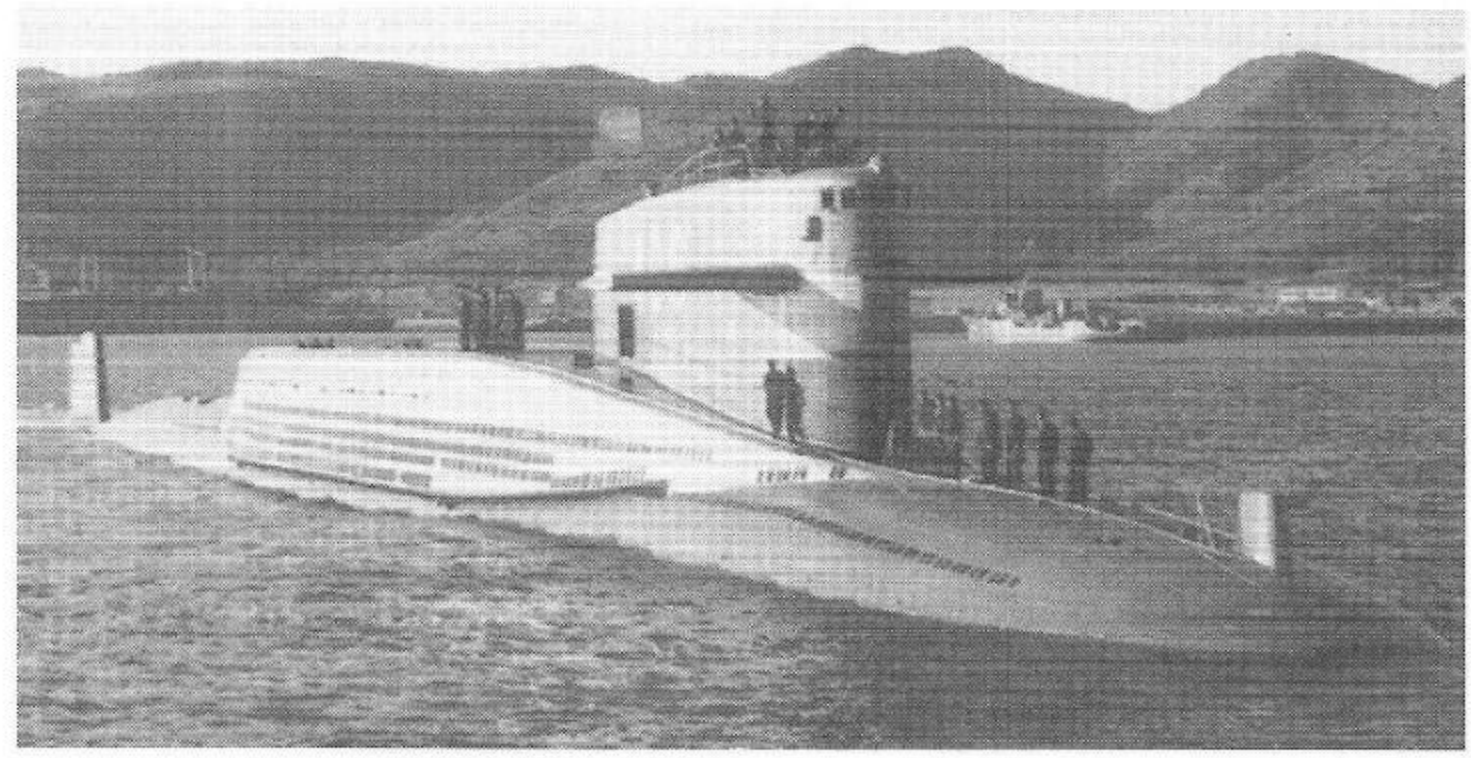
TORPEDOES

SET-65E torpedoes; Chinese-produced copies of Russian original.

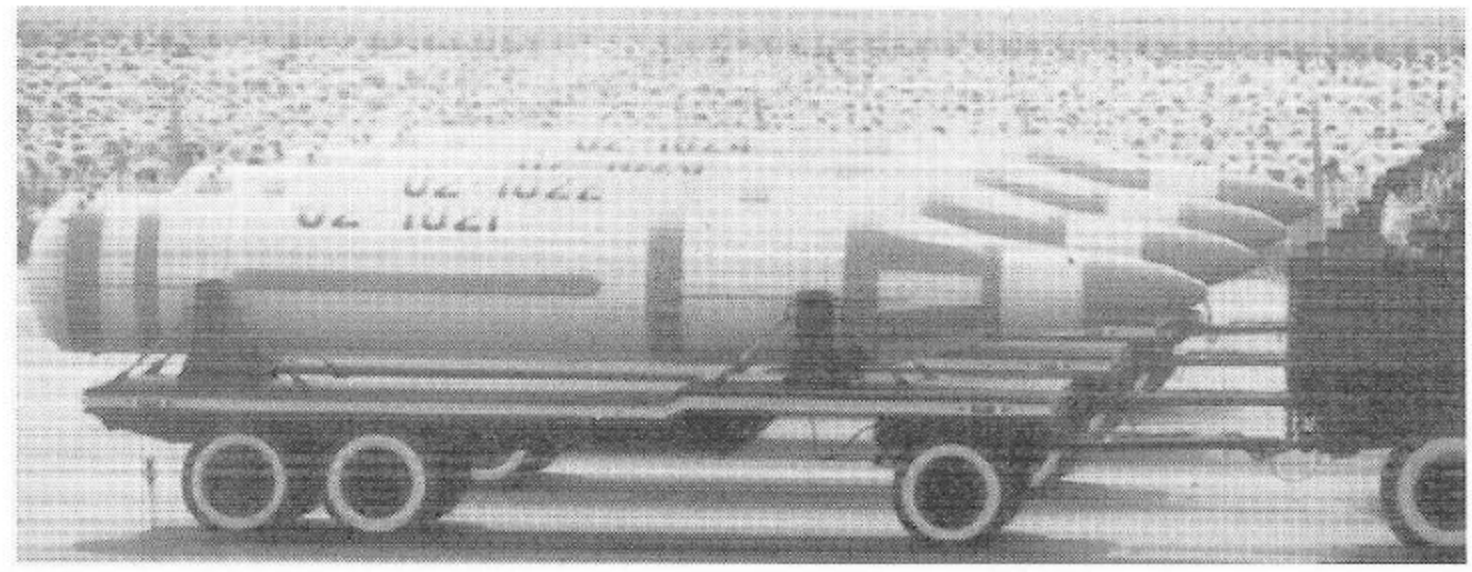
Specifications
Length: 7.8 m (25.6 ft)
Weight: 1,600 kg (3,527 lb)
Range: 10.75 n miles (20 km)
Max speed: 35 kts
Warhead: 372 kg (820 lb)
Homing: Passive



Ju Lang 1



The Chinese 'Daqingyu (Xia)' class SSBN carries 12 CSS-N-3 missiles and is a remarkable achievement for the Chinese missile and submarine industries



Chinese naval missile, Ju Lang 1 (CSS-N-3)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Radar Warning
Type 921-A.

COMMAND AND CONTROL SYSTEMS

RADAR

Air/surface search
Snoop Tray; I band.

SONAR

Trout Cheek; hull-mounted; active/passive search and attack; medium frequency.

PROPULSION

Specifications
Main machinery: Nuclear power plant with pressurised water reactor (PWR) and turbo-electric drive

Power output: 90 MW
Auxiliary power: 1 diesel
Shafts: 1

FURTHER INFORMATION

SUBMARINE PROGRAMME

The first Chinese SSBN was given the name 'Xia' class by Western Intelligence, since the Chinese name was not known at that time. It is now, however, known to be 'Daqingyu'. This submarine represents China's emergence as a true global power and is also of major significance as the first SSBN to be produced outside the well-established nuclear powers of France, Russia, UK and USA. It is also very significant that this is the only SSBN system in Asia and may well have been instrumental in prompting India to consider an SSBN programme of her own.

The 'Xia' class was built at Huludao yard, which is located some 200 km (120 miles) northeast of Beijing, where the 'Han' class SSNs are also built. The submarine was laid down in 1978 and launched in 1981, but then spent a lengthy period fitting out and conducting missile tests, not reaching operational status until 1987.

Unconfirmed Western reports suggest that a second 'Xia' class SSBN may have been launched in 1981 and that one of the two was lost at sea in 1985. In any event, the only extant submarine became operational in 1988 and serves with the North Sea Fleet.

MISSILE PROGRAMME

The PLA-N pioneered solid fuel rocket development in China which led, after a development phase lasting some ten years, to the Ju Lang-1 SLBM. (Chinese submarine-launched ballistic missiles (SLBM) are designated 'CSS-N-' (Chinese, surface-to-surface - naval) by Western Intelligence and 'Ju Lang' (giant wave) by the Chinese. An added complication is that the missile number designators do not agree with each other, since CSS-N-3 is the same missile as JL-1.)

The first test launch of the two-stage JL-1 missile took place on 30 April 1982 from a submerged pontoon in the Yellow Sea, near Huludao. The test was a success with the front end returning to the ocean 972 n miles (1,800 km) downrange. The second missile was launched from the PLA-N's 'Golf' class trials submarine on 12 October 1982 and was also a success, although it appears that the first launch from *Daqingyu (Xia)* on 15 October 1985 may have been unsuccessful, delaying final acceptance into service of the submarine. A successful (and widely publicised) launch took place on 27 September 1988.

According to early US estimates, the JL-1 is approximately equivalent in size and performance to the early US Navy Polaris SLBM. Recent reports that the missile (or possibly a newer version) now carries either three to four re-entry vehicles or a single warhead suggest, however, that it is probably more appropriate to suggest that it is equivalent to Poseidon.

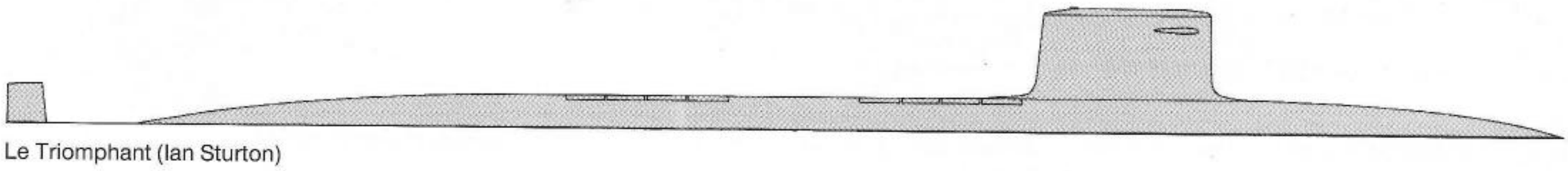
THE FUTURE

The 'Xia' class SSBN started a major refit at Huludao in late 1995. It is estimated that the work will take two years and will involve general updating including the fitting of a new missile system. A new class of SSBN (Type 093) is now under construction which will carry the new, longer-range, JL-2 missile system, which has been developed in parallel with the submarine platform. It is probable that the Xia will act as the testbed for this missile.

COMMENT

To maintain one submarine on continuous patrol takes a minimum of four and, to be absolutely safe, an optimum number of five hulls. The Chinese *Xia* class programme does not measure up to this criterion, but, on the other hand, it represents a major national achievement and experience with the Xia is doubtless providing many major inputs to the new submarine and missile systems, while its significance, which is sometimes treated somewhat dismissively in the West, is certainly not lost on the nations of the Pacific Rim. In a country which always takes a very long-term view of both political and military developments, however, the programme is probably well up to schedule.

LE TRIOMPHANT



Le Triomphant (Ian Sturton)

Le Triomphant (DGA/DCN)

GENERAL SPECIFICATIONS

Operator: France
Designation: *Sous-Marins Nucléaire Lance Engins (SNLE)*

Class: LE TRIOMPHANT

Active: 1
Building: 2
Proposed: 1

Displacement:
surfaced: 12,640 t
dived: 14,335 t
Length: 138 m (453 ft)
Beam: 12.5 m (41 ft); 17 m (55.8 ft) (aft planes)
Draught: 12.5 m (41 ft)
Keel to top of fin: 21.3 m (69.9 ft)

Speed, submerged: 25 kts
Diving depth: 500 m (1,640 ft)

Complement: 111 (15 officers) (two crews)

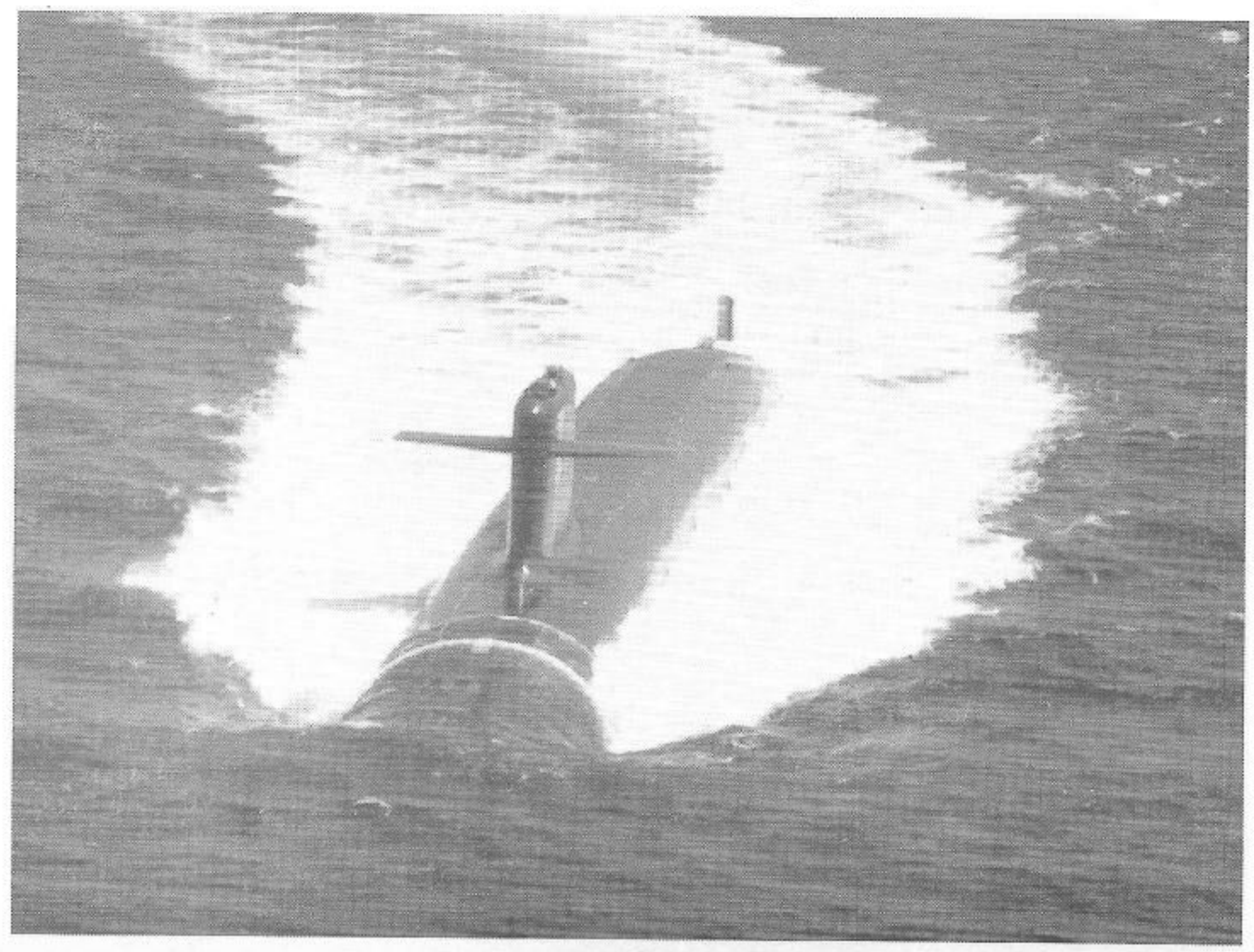
SUBMARINES

LE TRIOMPHANT (S 616)
Builder Cherbourg Naval Dockyard
Launched 13 Jul 1993
Commissioned Sep 1996

LE TEMERAIRE (S 617)
Builder Cherbourg Naval Dockyard
Launched 1997
Commissioned Jul 1999

LE VIGILANT (S 618)
Builder Cherbourg Naval Dockyard
Launched 2000
Commissioned Jul 2002

(Unnamed) (S 619)
Builder Cherbourg Naval Dockyard
Launched
Commissioned



Le Triomphant *(S 616) on sea trials; first of a new class of SNLE which entered service in September 1996* (DGA/DCN)

WEAPONS SYSTEMS

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBM)

Sixteen Aerospatiale MSBS M-45/TN-75

16 M-45 ballistic missiles with TN-75 warheads. The M-45/TN-75 combination was developed by France to maintain the credibility of its deterrent force in the face of increased anti-ballistic missile (ABM) defences in the (then) Soviet Union. The M-45 missile is essentially similar to the M-4A/B and also carries six RVs, in this case TN-75, but it has a further 540 n miles (1,000 km) range. French authorities have announced that the TN-75 weighs much less than the TN-71, which suggests that the extra range is a product of lighter payload rather than enhanced rocket thrust. Trial firings were carried out in 1991, 1993 and 1995, and the missile first went to sea as an operational system aboard *Le Triomphant* in 1996. It will be fitted in the first three 'Le Triomphant' class SSBNs. The TN-75 warhead has an estimated yield of 100 kT. The missiles are reported to carry penetration aids (presumably decoys) and the re-entry vehicles are hardened against laser attack and are specially shaped to reduce, if not eliminate, radar detection. Range is reported to be of the order of 6,000 km.

Specifications

M-45; TN-75 RVs
Type: 3-stage, solid fuel rockets with 6 TN-75 150 kT MRVs
Length: 11.07 m (36.33 ft)
Diameter: 1.95 m (6.33 ft)
Stages: 3
Weight (at launch): 35,000 kg (77,161 lb)
Propulsion:
total thrust: 1,049 kN (235,892 lb st)
combustion time: 176 s
Guidance: SAGEM inertial system, with star-fix and mid-course satellite update
Throw weight: 1,200 kg (2,646 lb) (estimate)
Range: 3,239 n miles (6,000 km)
Speed: 18,000 km/h (11,185 mph) (approx)
Warheads: 6 TN75 MRV
Warhead yield: 100 kT
Accuracy — circular error probable (cep): Better than 185 m (607 ft)

Manufacturer/Contractor

Aerospatiale, Space and Strategic Systems Division, Les Mureaux, France.

Four 533 mm (21 in) tubes.

SUBMARINE-LAUNCHED CRUISE MISSILES

Aerospatiale SM 39 Exocet

SM 39 Exocet launched from 533 mm (21 in) torpedo tubes. A total of 18 torpedoes and SM 39s is carried in a mixed load.

Specifications

Length: 5.21 m (17.09 ft)
Diameter: 35 cm (13.78 in)
Wing span: 1.00 m (3.28 ft)
Weight: 660 kg (1,455 lb)
Range: 2-27 n miles (4-50 km)
Speed: Mach 0.9
Guidance: Inertial and active radar
Warhead: 165 kg (364 lb)

Manufacturer/Contractor

Aerospatiale, Paris, France.

TUBES

Four 533 mm (21 in) tubes.

TORPEDOES

ECAN L5 Mod 3 heavyweight, dual-purpose torpedo.

Specifications

Length: 4.4 m (14.44 ft)
Diameter: 533.4 mm (21 in)
Weight: 1,300 kg (2,866 lb)
Range: 5.1 n miles (9.5 km)
Max speed: 35 kts
Warhead: 150 kg (331 lb)
Depth: to 550 m (1,800 ft)
Homing: Active/passive homing
Propulsion: Electric (silver/zinc batteries)

Manufacturer/Contractor

DCN International.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

DR 3000U ESM Receiver

DR 3000U ESM receiver offers threat detection, direction-finding, identification and target designation of enemy radars over the C- to J-frequency bands. The system uses the latest advances in gallium arsenide (GaAs) technology and is of modular and lightweight design. It has a high-sensitivity range covering the breadth of the frequency spectrum, with a detection capability of nearly 100 per cent. Direction-finding accuracy is understood to be in the order of 6°. Highly automated operation includes the use of artificial intelligence and allows for very short reaction times. The DR 3000U includes a 5 kg periscope aerial, or a 12 kg small DF aerial with six DF antennas (2 to 18 GHz), or a more sophisticated system consisting of GPS and a 30 kg DF aerial.

Specifications

Frequency: C- to J-bands
Azimuth coverage: 360°
Elevation coverage: −10 to +45°
Sensitivity: −68 dBm
Dynamic range: Up to 60 dB
Radar modes: 4,000 in library

Manufacturer/Contractor

Thomson-CSF, Radars and Countermeasures Division, Elancourt, France.

COMMAND AND CONTROL SYSTEMS

SUBMARINE-LAUNCHED BALLISTIC MISSILES CONTROL

Système d'Armes de Dissuasion (SAD)

SAD is command data system for the ballistic missiles. All details are classified.

SAT (Système d'Armes Tactique)

In 1987 Thomson-Sintra revealed the SUBICS (Submarine Integrated Combat System) with Colibri workstations. An improved version, designated SUBICS Mk II, appeared circa 1992 with Signaal SIGHT workstations and it is believed this is the basis for the SAD/SAT system in the new 'Le Triomphant' class submarines. Part of the system is the DLA 4A weapon control system (for SSM and torpedoes).

RADAR

Calypso IV (TRS 3110) radar

Calypso IV (TRS 3110) carries out airspace and surface surveillance while the submarine is on the surface, and is also used for navigation. There is a single operating console below and the rotating antenna is positioned atop a mast to give maximum coverage. An earlier version, Calypso III, is quoted as being able to detect a 10 m² target, such as an ASW aircraft, at 18 n miles and a height of 2,500 m (8,200 ft).

Specifications

Role: Surveillance and navigation
Frequency bands: I/J
Pulse: 1 ms
Range: min 10 n miles
Peak output power: 25 kW

Manufacturer/Contractor

Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

SONAR

Thomson Sintra DMUX 80

DMUX-80 is a multifunction, low-frequency, passive system consisting of bow and flank arrays. There is also a towed array. No details are available.

PROPULSION

Specifications

System: Nuclear; turbo-electric
Reactor: 1 pressurised water nuclear reactor; Type K15 (enlarged CAS 48)
Power output: 150 MW
Turbo-alternators: 2
Motors: 1–30.5 MW (41,500 hp(m))
Auxiliary propulsion: 2 SEMT-Pielstick 8 PA4 V 200 SM diesels; 900 kW; 1 emergency motor
Shafts: 1
Propulsor: pump jet

FURTHER INFORMATION

PROGRAMME

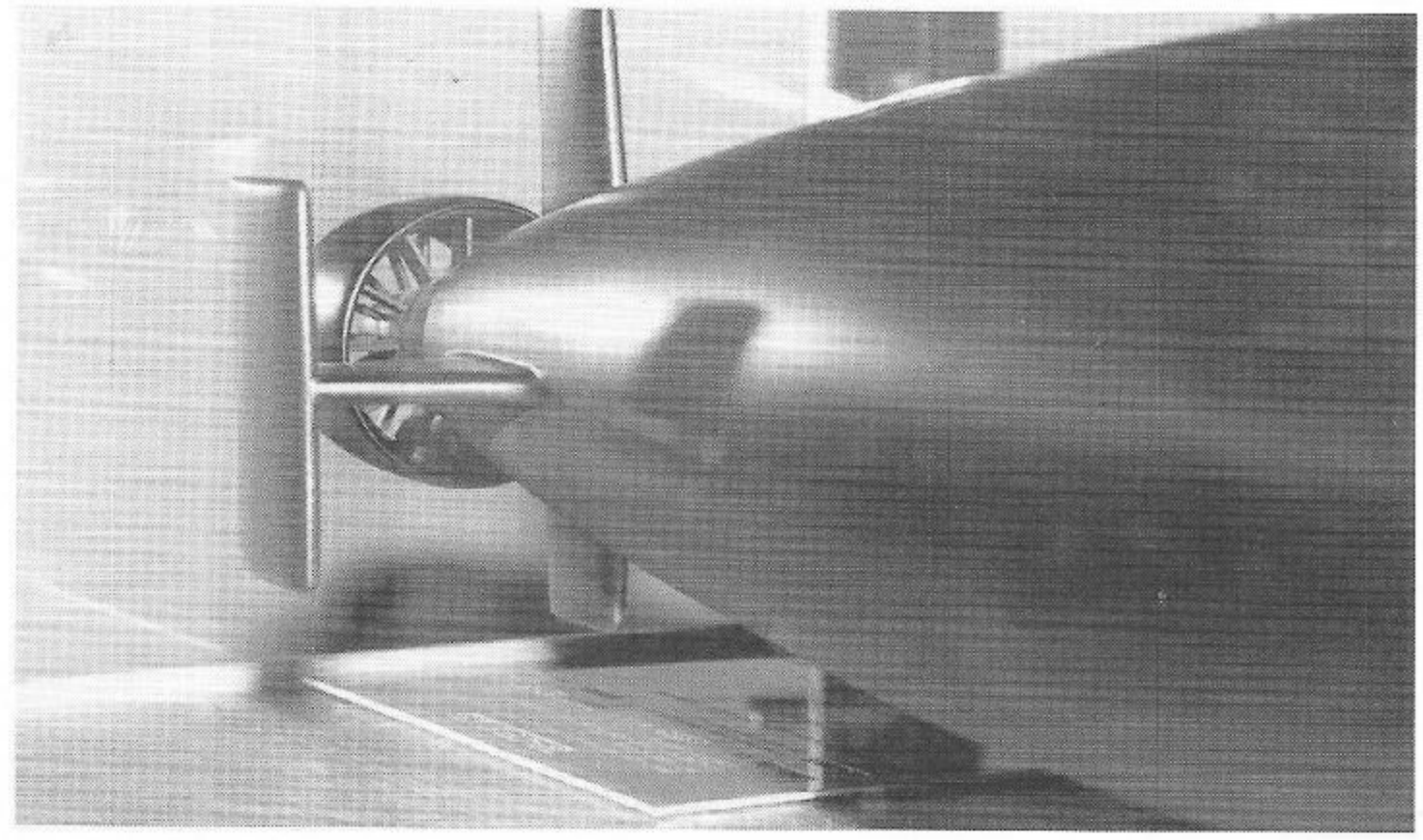
A class of six was originally planned to replace the 'Le Redoutable' class, but this has since been reduced to a total of four, with the orders being placed at lengthy intervals, in 1986, 1989, 1993 and, finally, 1996. They are officially known as the Sous-Marins Nucléaires Lanceurs Engins-Nouvelle Génération (SNLE-NG).

Le Triomphant started its builder's sea trials on 15 April 1994, followed by official trials starting on 1 July 1994. She will replace *Le Terrible* in 1996. The first submerged M45 launch took place on 14 February 1995.

DESIGN

These SNLE-NG represent a very considerable advance on the 'L'Inflexible' class, with a very smooth hull design, which is one of many measures intended to reduce the acoustic signature. They are built of HLES 100 steel, which is capable of withstanding pressures of more than 100 kg/mm² and enabling them to operate at a maximum depth of some 500 m (1,640 ft).

Le Triomphant was the first French submarine to be seen with a shrouded propulsor, which is a purely French development, unrelated to the British design. *Le Triomphant* also has vertical end plates on the after hydroplanes, presumably combining the functions of additional directional control with a mounting for a sonar system. It should also be noted that the forward hydroplanes are mounted high on the sail.

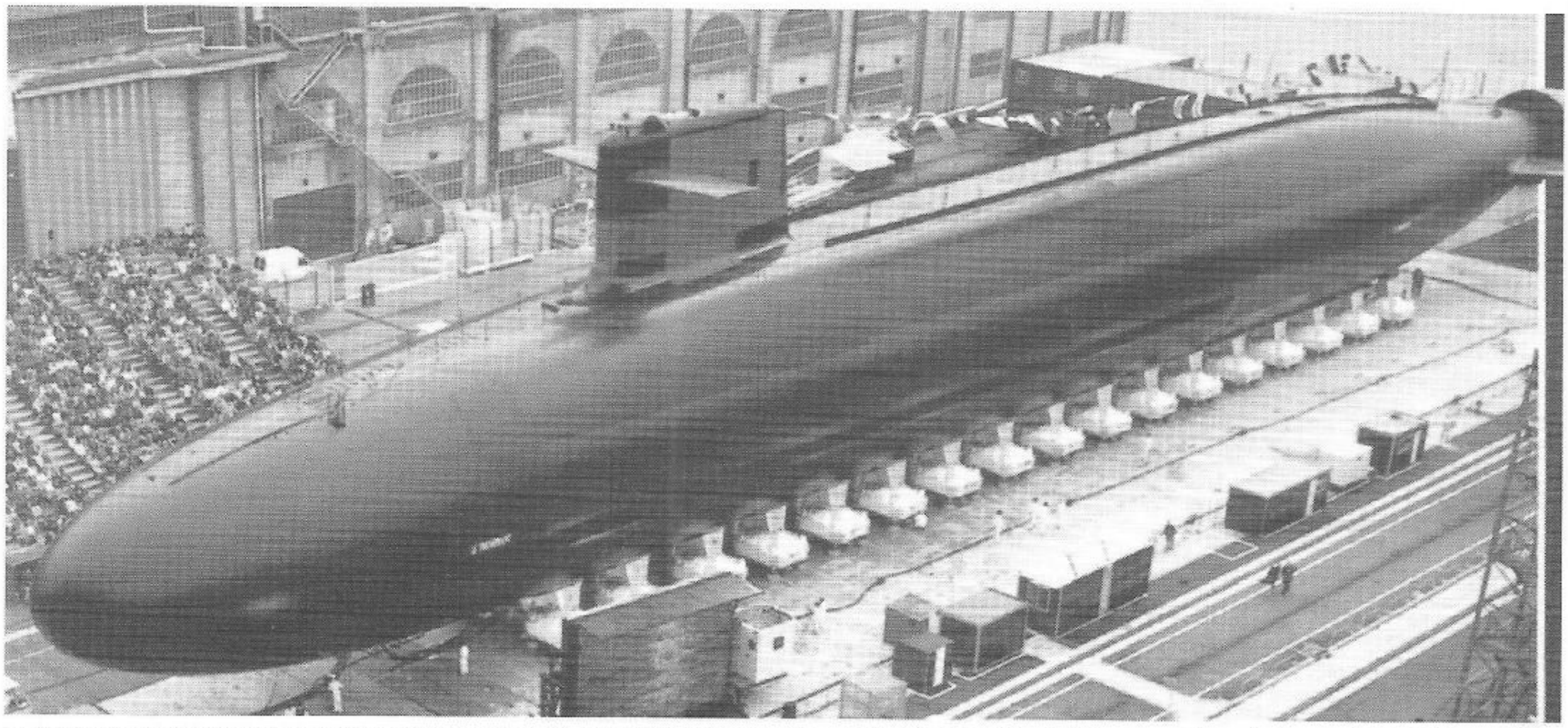


The stern of an official model of Le Triomphant *showing the shrouded propulsor and the endplates at the extremity of the after hydroplane which carry sonar arrays* (Jane's/David Miller)

MODERNISATION

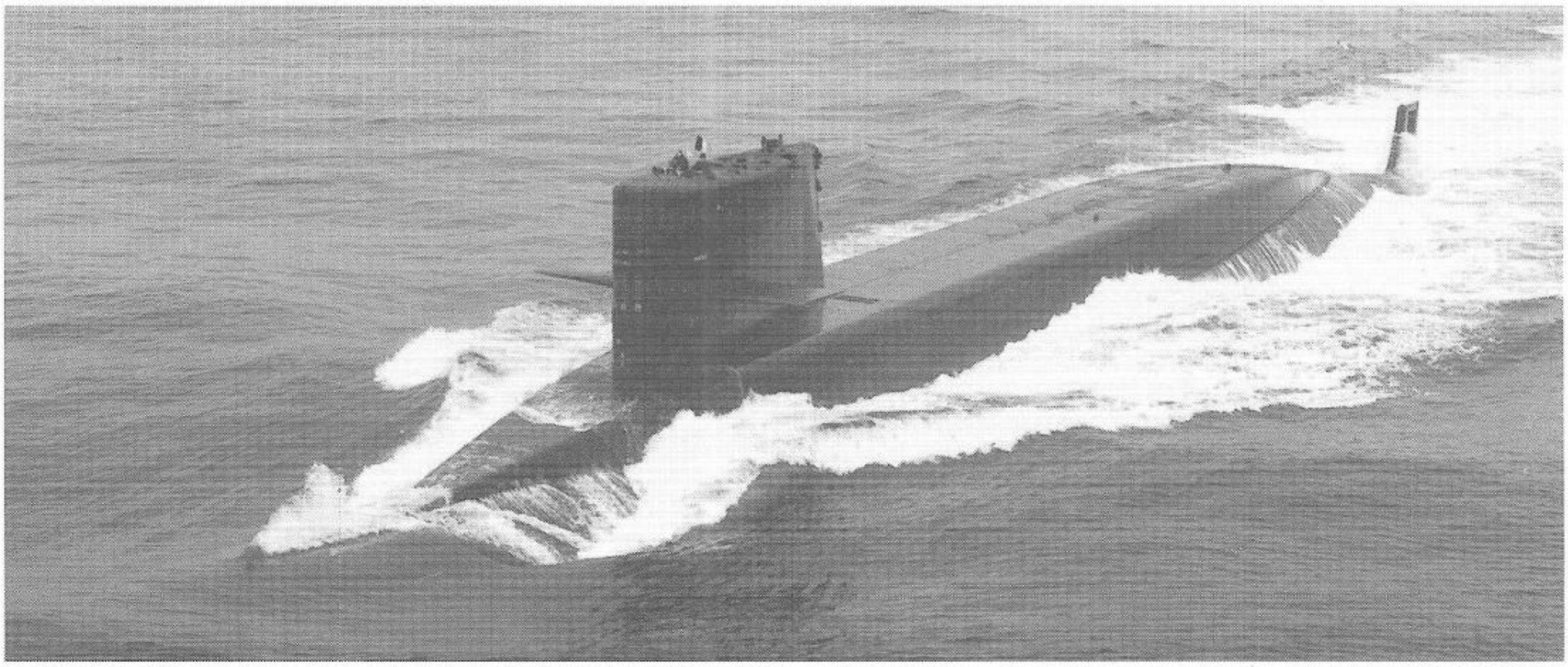
As built, all four submarines will be fitted to launch the M-45/TN-75 missile/RV. This installation will, however, be replaced to enable them to launch the all-new M 5/TN-76, which has a planned range of 6,000 n miles (11,000 km) carrying 10 to 12 MRVs. Retrofitting is currently planned to start with *Le Vigilant* in 2010, followed by the others in due course. Four sets of M-45 missiles were to have been ordered but this number may now be reduced.

At one stage there was a plan to lengthen the hull in later ships of the class, but this has now been shelved.



Le Triomphant *(S 616) at its launch at Cherbourg on 13 July 1993. The exceptional smoothness of the hull is apparent, as is the very large GRP moulding covering the bow sonar* (DGA/DCN)

L'INFLEXIBLE



Le Foudroyant *(S 610)* (SIRPA/ECPA)

GENERAL SPECIFICATIONS

Operator: France
Designation: *Sous-Marins Nucléaire Lance Engins (SNLE)*

Class: L'INFLEXIBLE

Built: 6
Active: 5
Building: 0

Displacement:
surfaced: 8,080 t
submerged: 8,920 t
Length: 128.7 m (422.1 ft)
Beam: 10.6 m (34.8 ft)
Draught: 10 m (32.8 ft)

Speed, submerged: 25 kts
Diving depth: 250 m (820 ft) approx

Complement: 130 (15 officers) (2 crews)

SUBMARINES

LE TERRIBLE (S 612)

Builder	Cherbourg Naval Dockyard
Laid down	24 Jun 1967
Launched	12 Dec 1969
Commissioned	1 Jan 1973

LE FOUDROYANT (S 610)

Builder	Cherbourg Naval Dockyard
Laid down	12 Dec 1969
Launched	4 Dec 1971
Commissioned	6 Jun 1974

L'INDOMPTABLE (S 613)

Builder	Cherbourg Naval Dockyard
Laid down	4 Dec 1971
Launched	17 Sep 1974
Commissioned	23 Dec 1976

LE TONNANT (S 614)

Builder	Cherbourg Naval Dockyard
Laid down	19 Oct 1974
Launched	17 Sep 1977
Commissioned	3 May 1980

L'INFLEXIBLE (S 615)

Builder	Cherbourg Naval Dockyard
Laid down	21 Mar 1980
Launched	23 Jun 1982
Commissioned	1 Apr 1985

WEAPONS SYSTEMS

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBM)

Aerospatiale M-4B/TN-70 or TN-71

Sixteen M-4 MSBS (Mer-Sol-Balistique-Stratégique) missiles, each with up to six TN-71 warheads. M-4 is a three-stage, intermediate-range missile, the range (M-4A — 4,000 km; M-4B — 5,000 km) being a significant improvement over that of the earlier M-20. The missile carries six re-entry vehicles, which are believed to have some independent targeting capability, indicating an additional guidance system incorporated within the delivery system.

Specifications

Length: 11.07 m (36.33 ft)
Diameter: 1.95 m (6.33 ft)
Stages: 3
Weight (at launch): 35,000 kg (77,161 lb)
Propulsion:
total thrust: 1,049 kN (235,892 lb st)
combustion time: 176 s
Guidance: SAGEM inertial system, with star-fix and mid-course satellite update
Throw weight: 1,200 kg (2,646 lb) (estimate)
Range:
M-4A: 4,000 km (2,167 n miles)
M-4B: 5,000 km (2,700 n miles)
Speed: 18,000 km/h (11,185 mph) (approx)
Warheads: 6 TN71 MRV
Accuracy (cep): Better than 185 m (607 ft)

Manufacturer/Contractor

Aerospatiale, Space and Strategic Systems Division, Les Mureaux, France.

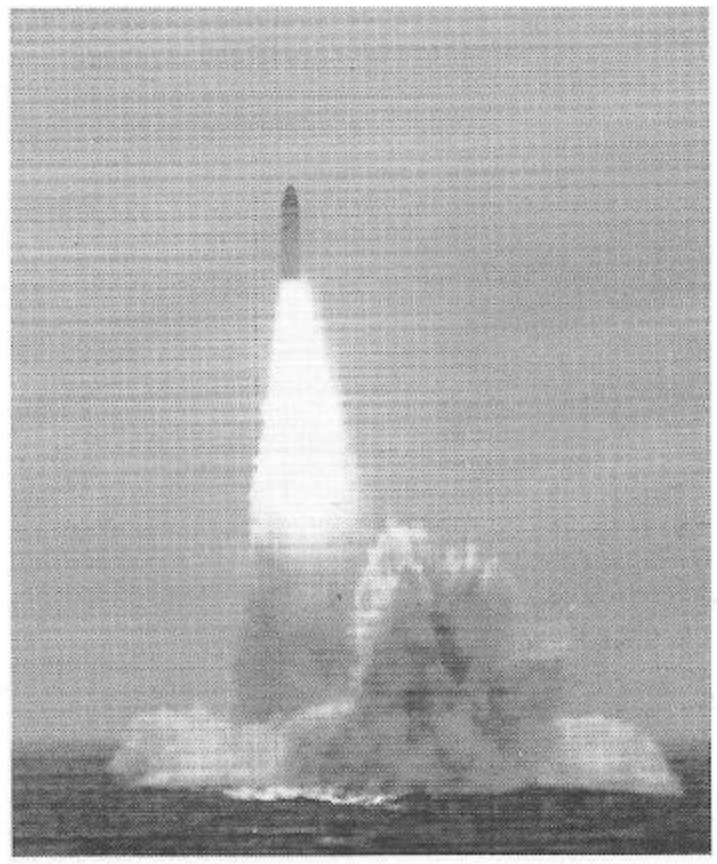
SUBMARINE-LAUNCHED ANTI-SHIP MISSILES

Aerospatiale SM 39 Exocet

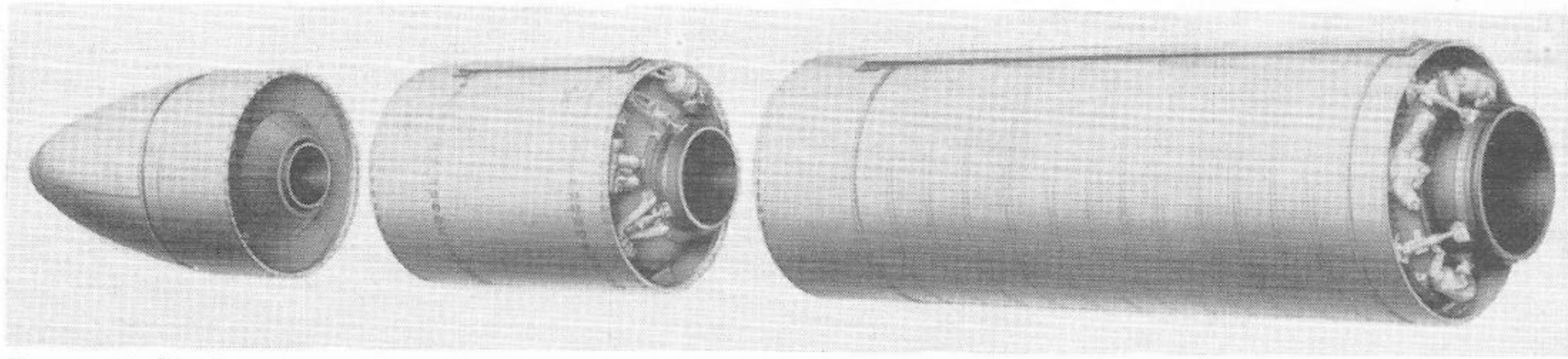
It is intended that all this class will carry SM 39 Exocet launched from the four 533 mm (21 in) tubes. Some have already been converted; the rest are following.

Specifications

Length: 5.21 m (17.09 ft)
Diameter: 35 cm (13.78 in)



French M-4 lifts off following a submerged launch (Aerospatiale)



Components of the 3-stage M-4 missile (Aerospatiale)

Wing span: 1.00 m (3.28 ft)
Weight: 660 kg (1,455 lb)
Range: 2-27 n miles (4-50 km)
Speed: Mach 0.9
Guidance: Inertial and active radar
Warhead: 165 kg (364 lb)

Manufacturer/Contractor
Aerospatiale, France.

TUBES

Four 533 mm (21 in) tubes in bows.

TORPEDOES

ECAN L5 Mod 3 heavyweight, dual-purpose torpedo.

Specifications
Length: 4.4 m (14.44 ft)
Diameter: 533.4 mm
Weight: 1,300 kg (2,866 lb)
Range: 5.1 n miles (9.5 km)
Max speed: 35 kts
Warhead: 150 kg (331 lb)
Depth: to 550 m (1,800 ft)
Homing: active/passive homing
Propulsion: electric (silver/zinc batteries)

Manufacturer/Contractor
DCN International.

ECAN F17 Mod 2 heavyweight, dual-purpose torpedo.

Specifications
Length: 5.4 m (17.7 ft)
Diameter: 533.4 mm
Weight: 1,406 kg (4,000 lb)
Range: 10.75 n miles (20 km)
Max speed: 28/40 kts
Warhead: 250 kg (551 lb) HBX3
Depth: 6-20 m (20-66 ft) against surface ship; 30 m (98.5 ft), 100 m (328 ft), 200 m (656 ft) against subs
Guidance: wire and automatic passive/active homing
Propulsion: electric (silver/zinc batteries)

Manufacturer/Contractor
DCN International.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

DR 3000U ESM Receiver
DR 3000U ESM receiver offers threat detection, direction-finding, identification and target designation of enemy radars over the C- to J-frequency bands. The system uses the latest advances in gallium arsenide (GaAs) technology and is of modular and lightweight design. It has a high-sensitivity range covering the breadth of the frequency spectrum, with a detection capability of nearly 100 per cent. Direction-finding accuracy is understood to be in the order of 6°. Highly automated operation includes the use of artificial intelligence and allows for very short reaction times. The DR 3000U includes a 5 kg periscope aerial, or a 12 kg small direction-finding (DF) aerial with six DF antennas (2 to 18 GHz), or a more sophisticated system consisting of GPS and a 30 kg DF aerial.

Specifications
Frequency: C- to J-bands
Azimuth coverage: 360°
Elevation coverage: −10 to +45°
Sensitivity: −68 dBm
Dynamic range: Up to 60 dB
Radar modes: 4,000 in library

Manufacturer/Contractor
Thomson-CSF, Radars and Countermeasures Division, Elancourt, France.

COMMAND AND CONTROL SYSTEMS

SUBMARINE-LAUNCHED BALLISTIC MISSILES CONTROL

Système d'Armes de Dissuasion (SAD)
SAD is command data system for the ballistic missiles. All details are classified.

Système d'Armes Tactique (SAT)
The Système d'Armes Tactique (SAT) stems from the Amethyste *(AMElioration Tactique HYdrodynamique Silence Transmission Ecoute)* programme and is a federated command data architecture with three subsystems: *Détection Sous-Marine* (DSM), *Traitement des Informations Tactiques* (TIT) and *Lancement des Armes Tactiques (LAT),* which are linked to each other by digital databuses. It is believed they can track up to 20 targets automatically and 30 manually while conducting TMA (target motion analysis) on four. Two torpedoes may be controlled simultaneously.

The DSM element of the L'Inflexible system comprises the DUUX 5 passive ranging and intercept sonar, complemented by the DSUX 21 flank and bow array, and the DSUV 61 towed array. DUUX 5 (sometimes called Fenelon) consists of two arrays of three hydrophones on each side of the submarine, operating in the 2 to 15 kHz band. Range information is provided over arcs of 12° and automatically transmitted to the SAD, with up to four targets being tracked simultaneously (one on sonar pulses and the others on radiated noise). Bearing accuracy can be down to 0.3°, discrimination accuracy to 2°. The DSUX 21 is reported to include passive flank and active bow sonar arrays. The DSUV 61 towed array sonar consists of some 20 to 50 hydrophones on a 100 to 300 m cable and is principally designed to warn off potentially hostile contacts so that the submarine can evade them.

The DSM is linked via the databus to the TIT tactical data handling subsystem, which uses sensor data to perform tactical picture compilation and TMA. This is then displayed and, when necessary, used for target designation to the LAT subsystem. The TIT is a mainframe system consisting of a computer with disk-based mass memory unit cabinet and printer unit. It is directly linked to an automatic plotting table, and also to two single-operator display systems through a coupling-device cabinet.

The LAT subsystem is actually one of the DLA weapon control family. In the 'L'Inflexible' class, the DLA 1A is used to control SSMs and torpedoes.

RADAR

Calypso IV (TRS 3110) radar
Calypso IV (TRS 3110) carries out airspace and surface surveillance while the submarine is on the surface, and is also used for navigation. There is a single operating console below and the rotating antenna is positioned atop a mast to give maximum coverage. An earlier version, Calypso III, is quoted as being able to detect a 10 m^2 target, such as an ASW aircraft, at 18 n miles and a height of 2,500 m (8,200 ft)

Specifications
Role: Surveillance and navigation
Frequency bands: I/J
Pulse: 1 ms
Range: min 10 n miles
Peak output power: 25 kW

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

PROPULSION

Specifications
System: nuclear
Reactor: 1 pressurised water nuclear reactor
Turbo-alternators: 2
Electric motor: 1 Jeumont Schneider motor
Power output: 11.76 MW (16,000 hp(m))
Propulsion:1 shaft; 1–5-bladed propeller
Auxiliary power:
diesels: 2 SEMT-Pielstick/Jeumont Schneider 8 PA4 V 185 SM diesel engines
electric: 1 motor
power output: 1.5 MW (2,040 hp (m))
range: 5,000 n miles at 4 kts on auxiliary propulsion only

FURTHER INFORMATION

PROGRAMME

The French Navy originally built five SNLEs of the 'Le Redoutable' class, followed by a sixth ship, *L'Inflexible,* of a modified and more advanced design. Since then, the last four ships of the original five SNLEs have been modified up to the new standard set by *L'Inflexible,* while the first of the original class, *Le Redoutable,* was not modified and was stricken in 1991. The remaining five ships are all now known as the 'L'Inflexible' class, or, alternatively, as SNLE M4.

Like the British, the French decided that a submarine-based nuclear deterrent was essential to their national defence, but, unlike the British, the French had to do it with very little help from the United States, although recent revelations suggest that there was some help of a covert nature. Early French missiles were thus heavier, carried smaller warheads and had much shorter ranges than their American equivalents, but a consistent national effort spread over many years has resulted in a nuclear force of the first rank.

The first fruit of that labour was the submarine *Le Redoutable* armed with sixteen MSBS-1 (Mer-Sol Ballistique Stratégique) missiles in two rows of eight abaft the fin, as in the contemporary US Navy's Polaris submarines. The MSBS M-1 had a range of only some 1,500 n miles (2,400 km). From the start, the French decided to build a force of five submarines, although an order was placed in late 1978 for a sixth boat of a more advanced design, *L'Inflexible.*

MISSILE PROGRAMME

The M-4 is the fourth missile in the family which comprises a number of submarine-launched, intermediate-range missiles, similar in form to the US Polaris and Poseidon families. The first land-based test launch took place in November 1980, with the 14th and final test firing taking place from the diesel-electric test submarine, *Le Gymnote,* on 29 February 1984; the system then entered service aboard *L'Inflexible* in 1985. Since then it has replaced the earlier M-20s in *Le Tonnant, L'Indomptable, Le Terrible* and *Le Foudroyant,* but not in the first of class, *Le Redoutable,* which was retired in 1991. The principal qualitative improvements in the M-4 over its predecessor, the M-20, are in range and payload, the M-4 being upgraded to include multiple re-entry vehicles.

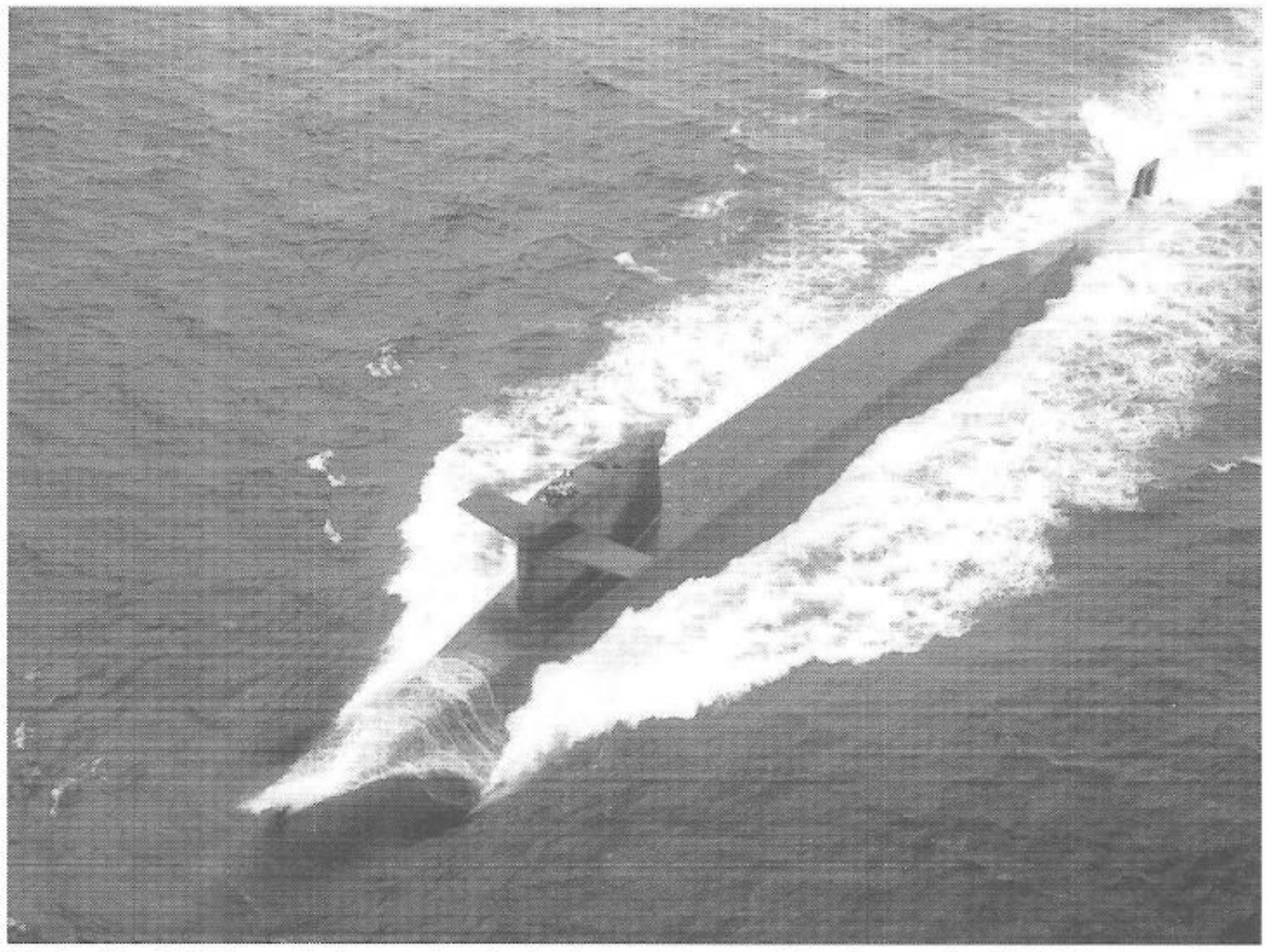
Reports indicate there are two versions of the M-4 missile in service; M-4A with a range of 4,000 km and M-4B with a range of 5,000 km. Reports also suggest that there are 16 (one boat load) M-4A missiles and 48 (three boat loads) M-4B missiles in service.

MODERNISATION

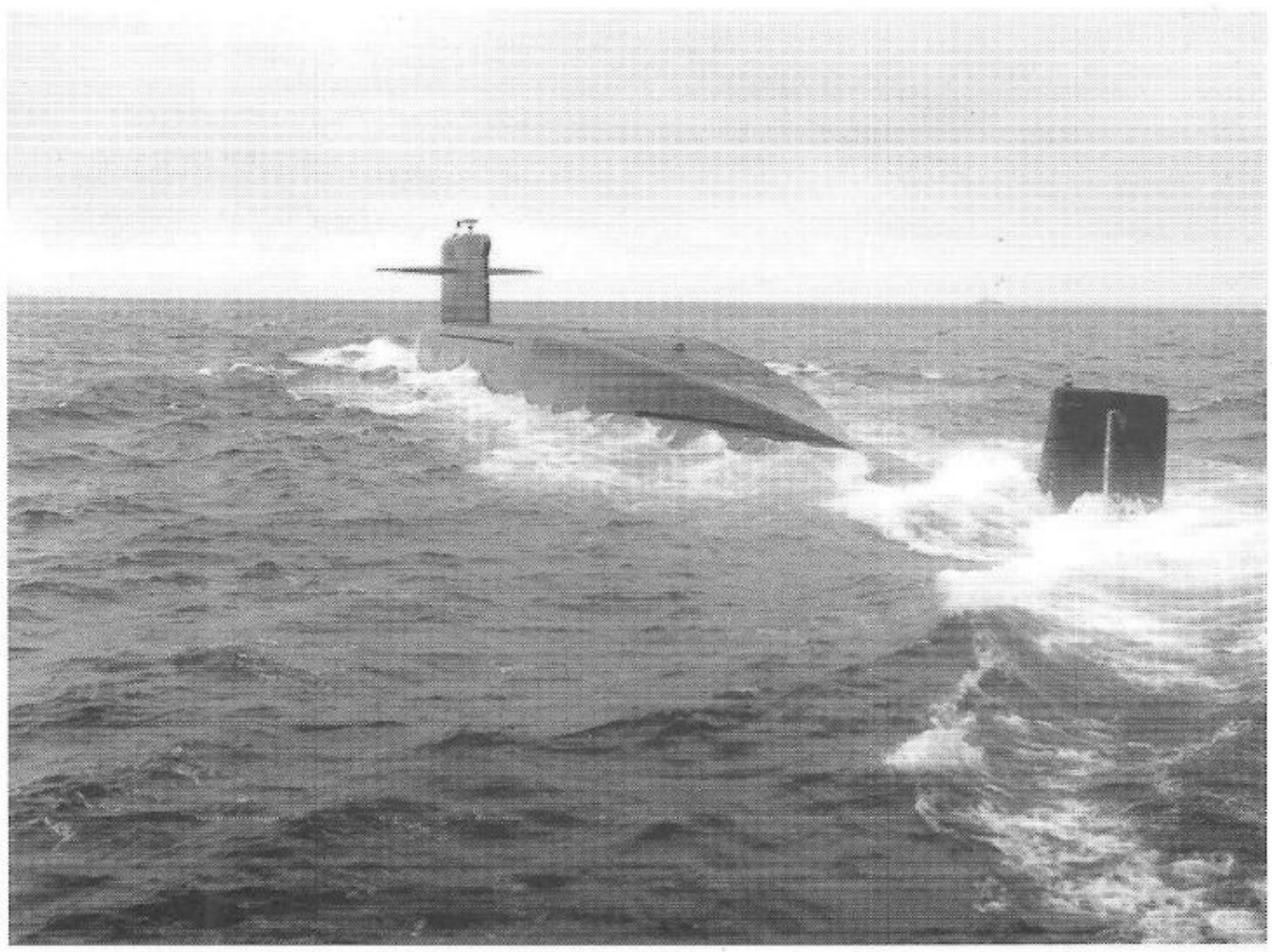
Of the five earlier boats, the first, *Le Redoutable,* was paid off in December 1991, but the other four have undergone long refits, which have effectively brought them up to the same standard as *L'Inflexible,* which is now the nameship of the class. *Le Tonnant* recommissioned on 15 October 1987, followed by *L'Indomptable* on 1 July 1989, *Le Terrible* on 11 June 1990 and *Le Foudroyant* on 15 February 1993. The work involved fitting the M-4 missile system, as well as an improved reactor core, noise reduction features, updating sonar and other equipment to the same standard as *L'Inflexible* on build.

STRUCTURE

In the original design the French SNLEs had a prominent 'turtle-back' with a sharp entry at the front, which was changed and made more streamlined during the refit. The sail was also reconstructed. These and other changes to match *L'Inflexible*'s improved streamlining, have resulted in much reduced acoustic signatures.



L'Inflexible *(S 615) was built to an interim design and the remaining four earlier SNLEs have now been brought up to virtually the same standard* (DCN/Jean Biaugeaud)



L'Inflexible *(S 615). Note the high-mounted forward hydroplanes* (DCN/Jean Biaugeaud)

OPERATIONAL

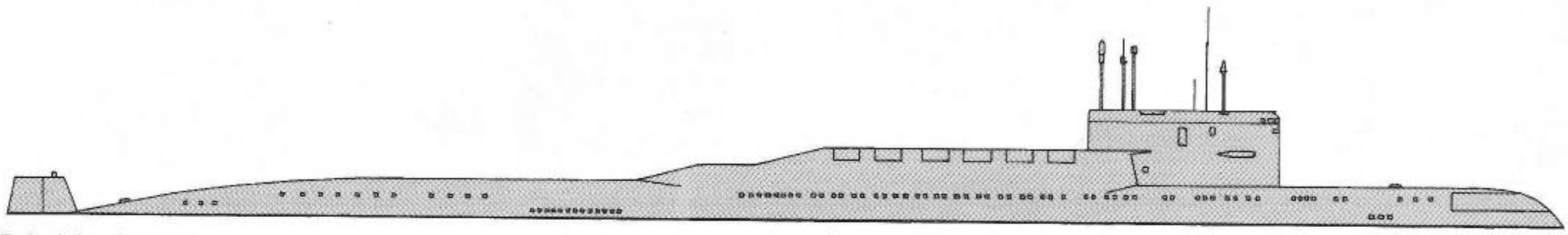
The SNLEs operate from the French strategic base at Ile de Longue, opposite Brest. The first operational launch of the M-4 missile was made by *Le Tonnant* on 5 September 1987 in the Atlantic and the 26th operational launch was on 26 October 1994.

THE FUTURE

Under current plans the three oldest remaining SNLEs will pay off as follows, being replaced by new SNLEs of the 'Le Triomphant' class:

Le Terrible — late 1996
Le Foudroyant — late 1998
L'Indomptable — 2001.

DELTA I (MURENA)



Delta I (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: Russia
Type: Nuclear-powered, ballistic missile submarine (SSBN)
Designation: *Podvodnaya Lodka Atomnaya Raketnaya Ballisticheskaya* (PLARB)

Class: DELTA I (MURENA) (Type 667B)

Built: 18
Active: See 'Further Information'

Building: 0
Proposed: 0

Displacement:
surfaced: 8,700 t
submerged: 10,200 t
Length: 140 m overall; 136 m waterline (459.3 ft; 446.2 ft)
Beam: 12 m (39.4 ft)
Draught: 8.7 m (28.5 ft)

Speed: 25 kts dived
Endurance: 90 days
Diving depth: 300 m (1,000 ft)

Complement: 120

SUBMARINES

No details are available, except that 18 ships entered service between 1972 and 1977.

WEAPONS SYSTEMS

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBM)

SS-N-8 (Russia = RSM-40 Vysota) (NATO = Sawfly)

Twelve SS-N-8 two-stage, liquid propellant, SLBMs, located in a turtle-back housing abaft the sail. There are two versions; Mod 1 with a single 1 MT warhead and Mod 2 with two re-entry vehicles, probably of around 800 kT each and a much greater range, 4,900 n miles (9,100 km) compared to 4,200 n miles (7,800 km). In 1991, however, the Russians formally declared that only the Mod 1 remains in service.

Specifications

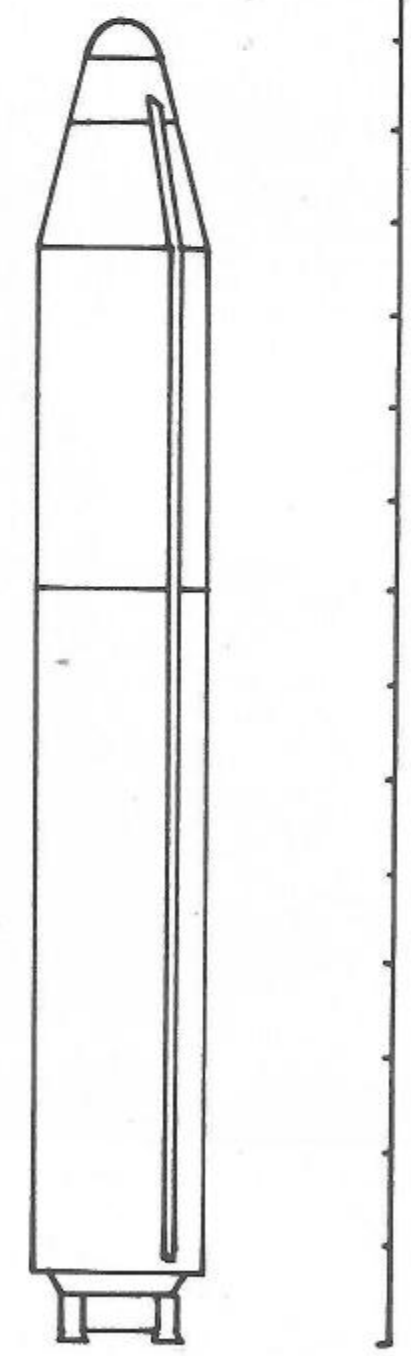
SS-N-8 Mod 1
Length: 14.20 m (46.59 ft)
Body diameter: 1.80 m (5.9 ft)
Launch weight: 33,300 kg (73,413 lb)
Fuel: Unsymmetrical dimethyl hydrazine and nitrogen tetroxide liquids
Burn times:
1st stage: 150 s
2nd stage: 80 s
Payload: Single RV
Warhead: 1 MT nuclear
Guidance: Inertial with stellar reference update
Propulsion: 2-stage liquid
Range: 4,210 n miles (7,800 km)
Accuracy — circular error probable (cep): 0.22 n miles (400 m)
Throw weight: 1,150 kg (2,535 lb)

Specifications

SS-N-8 Mod 2
As for Mod 1, but:
Payload: 2 RVs in MRV configuration
Warhead: 2—800 kT nuclear
Range: 4,910 n miles (9,100 km)

Manufacturer/Contractor

Makeyev Design Bureau



SS-N-8

TUBES

Four 533 mm (21 in); two 406 mm (16 in).

TORPEDOES

Total weapon load, 18 weapons.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Brick Group is a radar warning system, comprising Brick Pulp and Brick Spit, both of which have rotating antennas housed in radomes.

Direction-finding

Park Lamp: VLF/LF receiving antenna, consisting of four open loops, mounted on its own mast.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS

ELF/VLF communications with floating aerial and buoy
UHF and SHF aerials
Kremmny 2 IFF.

NAVIGATION

Cod Eye radiometric sextant.

RADAR

Snoop Tray
Snoop Tray is a surface search radar, operating in I-band. As its name implies, it has a rectangular, virtually flat antenna

SONARS

Shark Teeth
Bow-mounted, passive/active search and attack sonar, operating at low/medium frequency.

Mouse Roar
Hull-mounted, active attack, high-frequency sonar.

PROPULSION

Specifications

System: Nuclear
Reactors: 2—VM-2 pressurised water nuclear reactors
Power output: 160 MW
Steam turbines: 2
Power output: 27.5 MW (37,400 hp(m))
Shafts: 2

FURTHER INFORMATION

SUBMARINE PROGRAMME

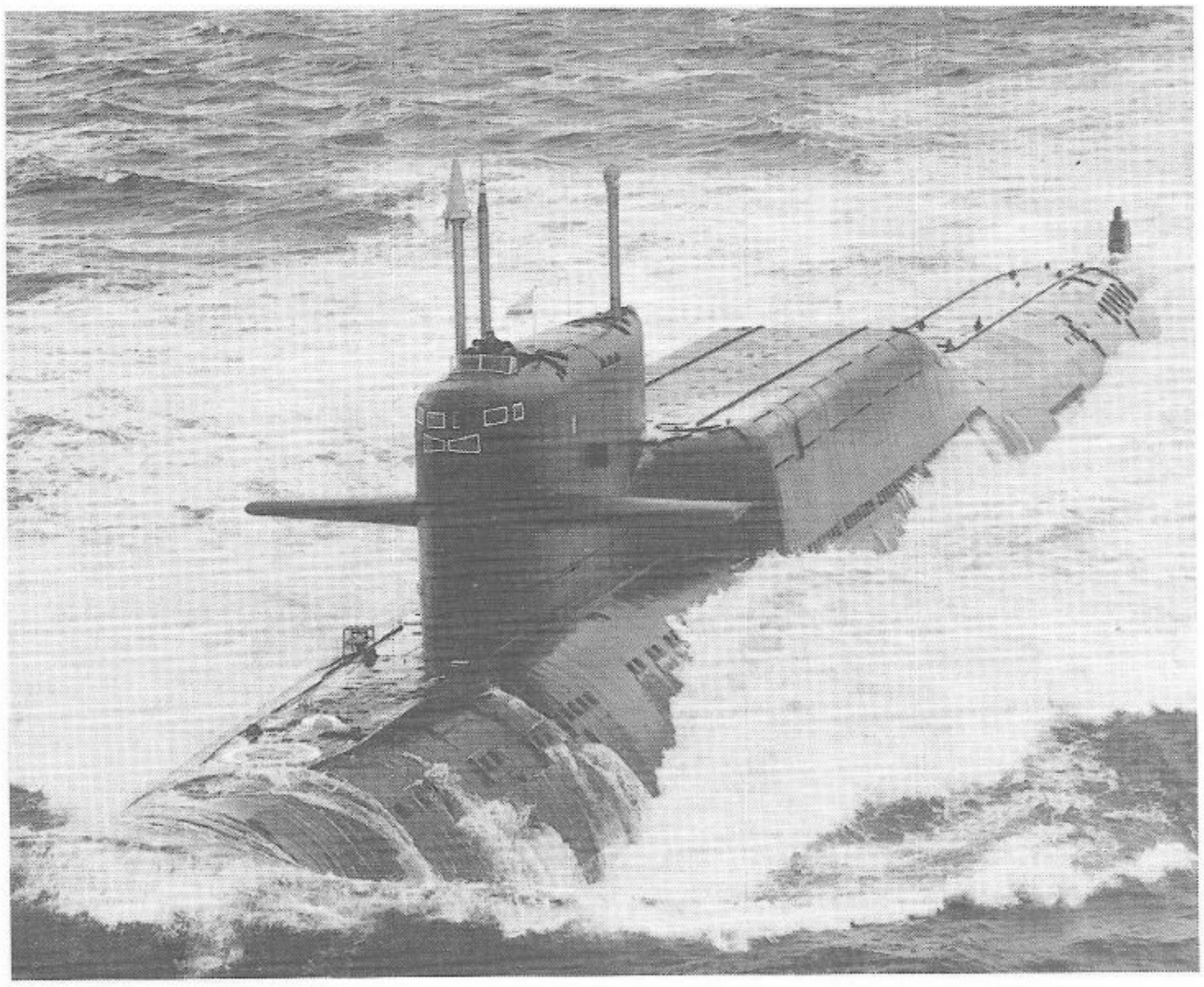
It would appear that Soviet designers took the 'Yankee' class SSBN as the start-point for their Delta I (Murena) design, which was required to take the new SS-N-8 missile to sea. The first of class was laid down at Severodvinsk in 1969 and completed in 1972, with the construction of all 18 completed by 1974. Ten were built at Severodvinsk and eight in the Far East at Komsomolsk. The major unusual feature of the Delta I is that it carries only 12 missiles, a characteristic it shared only with the Yankee II until the appearance of the Chinese 'Xia' class. Of the eight remaining ships, three are based in the Northern Fleet and five in the Pacific Fleet.

MISSILE PROGRAMME

When first detected in the West, SS-N-8 caused considerable alarm, the then Chairman of the Joint Chiefs of Staff declaring that its range exceeded that of any other known SLBM by at least 1,620 n miles (3,000 km) and thus introducing a 'totally new problem' into Western defence planning. The further discovery that the new missile also used stellar sensing techniques to reduce its cep to some 400 m did nothing to allay Western alarm.

Development of SS-N-8 began in 1961 and the missile started flight tests from a converted 'Hotel' class submarine in 1971, entering service aboard the first Delta I in 1971.

In 1994 actual deployment of SS-N-8 missiles was: 244 missiles operational, with a further 177 stored at the operational bases, Revna and Okolnya. In addition, 146 SS-N-8 missiles were at the Pashino conversion/elimination facility.



Delta I. The raised masts carry (from left to right) Pert Spring, a VHF whip antenna and Snoop Tray search radar

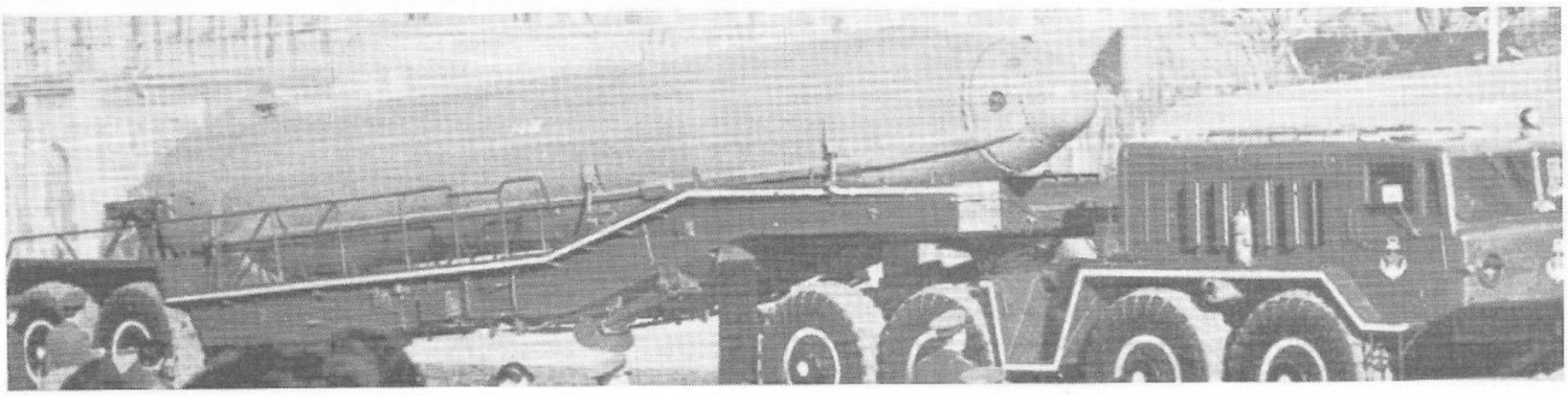
DESIGN

The longer-range SS-N-8 missiles are of greater length than the SS-N-6s, which, since this length could not be accommodated below the keel, meant that the turtle-back covering their launch tubes had to stand several feet proud of the after-casing. At the same time, the need to compensate for the additional top weight would seem to be the reason for the reduction to 12 missiles in this class. The outer casing has a continuous 'acoustic' coating. As with the other versions of the 'Delta' class, this submarine is ill-designed for under-ice operations.

THE FUTURE

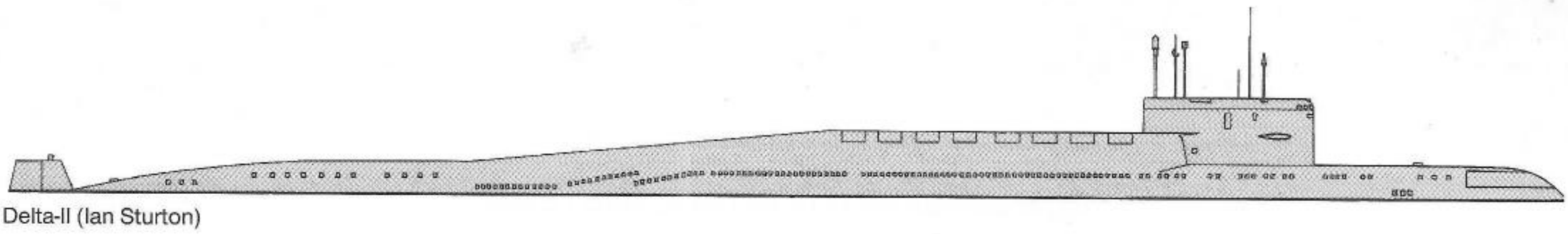
The Delta I force stood at 18 from 1976 to 1992, when the first was paid off, followed by three more in 1993, six more in 1994 and one in 1995. Proposals have been made that redundant 'Delta 1' class submarines should be used as launch platforms for the 'Vysota' satellite launch vehicle, which is capable of orbiting a 130 kg (287 lb) payload into a 250 km circular orbit, which would use a two-stage liquid propellant SS-N-8 'Sawfly' missile as the launch vehicle.

Another proposal is to convert one as a rescue submarine, carrying a Deep-Sea Rescue Vehicle (DSRV). The actual status of these submarines is doubtful and they may already have been taken out of service.



SS-N-8 on land transporter

DELTA-II (MURENA-M) CLASS



Delta-II (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: Russia
Designation: *Podvodnaya Lodka Atomnaya Raketnaya Ballisticheskaya* (PLARB)

Class: DELTA-II (MURENA-M) (Type 667BD)

Built: 4
Active: See 'Further Information'

Displacement:
surfaced: 9,700 t
submerged: 11,750 t
Length: 155 m overall; 152 m waterline (508.4 ft; 498.7 ft)
Beam: 12 m (39.4 ft)
Draught: 8.7 m (28.5 ft)

Speed:
surfaced: 19 kts
dived: 24 kts
Diving depth: 300 m (1,000 ft)

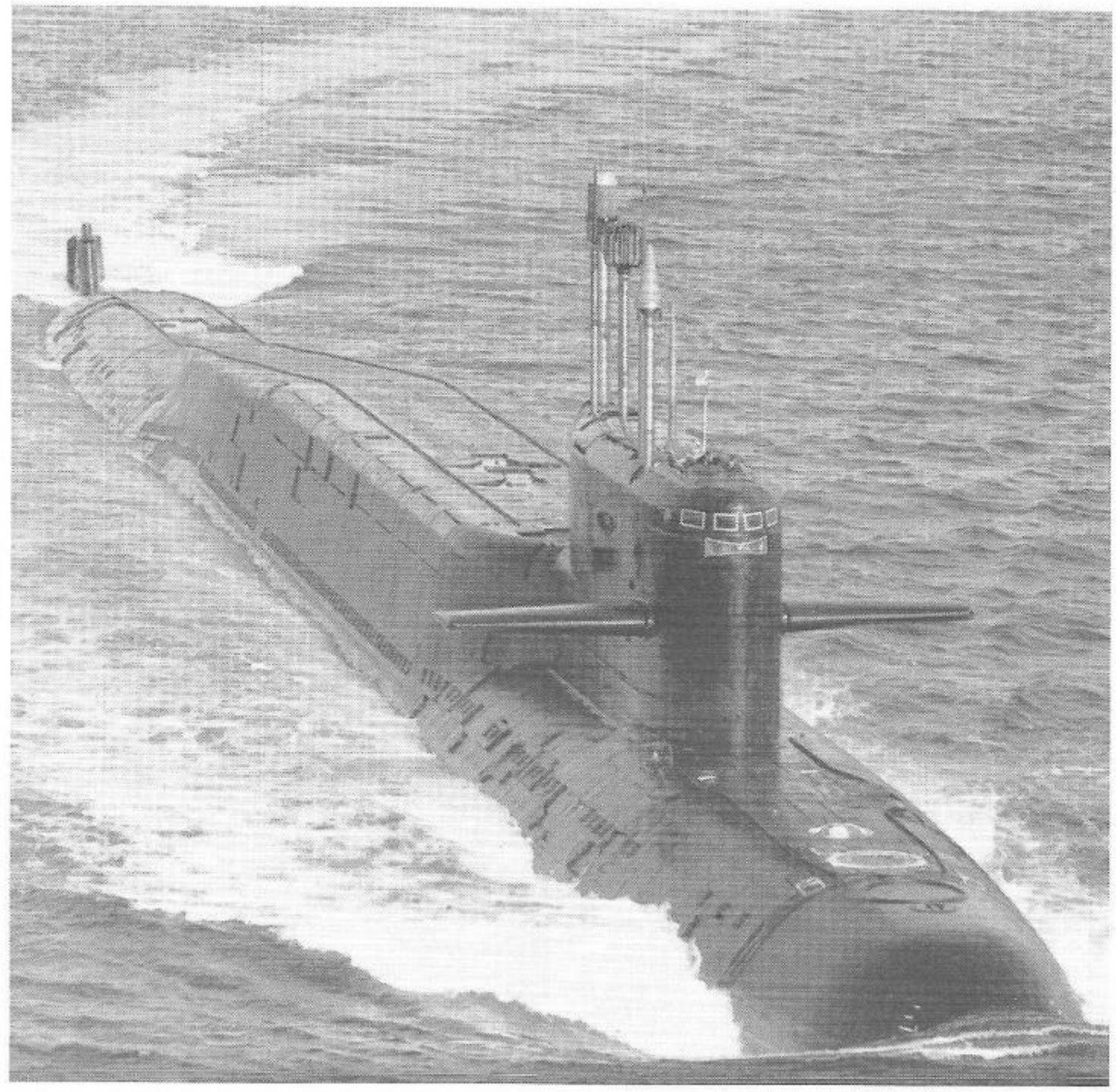
Complement: 130

SUBMARINES

K 421
Commissioned 1974

K 92
Commissioned 1974

K 193
Commissioned 1975



Delta II

WEAPONS SYSTEMS

TUBES

Four 533 mm (21 in); two 406 mm (16 in).

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBM)

SS-N-8 (Russia = RSM-40 Vysota) (NATO = Sawfly)

Sixteen SS-N-8 two-stage, liquid propellant, SLBMs, located in a turtle-back housing abaft the sail. Although two versions (Mod 1 and Mod 2) were developed, only Mod 1 remains in service.

Specifications
SS-N-8 Mod 1
Length: 14.20 m (46.59 ft)
Body diameter: 1.80 m (5.9 ft)
Launch weight: 33,300 kg (73,413 lb)
Fuel: Unsymmetrical dimethyl hydrazine and nitrogen tetroxide liquids
Burn times:
1st stage: 150 s
2nd stage: 80 s
Payload: single RV
Warhead: 1 MT nuclear
Guidance: Inertial with stellar reference update
Propulsion: 2-stage liquid
Range: 4,210 n miles (7,800 km)
Accuracy — circular error probable (cep): 0.22 n miles (400 m)
Throw weight: 1,150 kg (2,535 lb)

Specifications
SS-N-8 Mod 2
As for Mod 1, but:
Payload: 2 RVs in MRV configuration
Warhead: 2–800 kT nuclear
Range: 4,910 n miles (9,100 km)

Manufacturer/Contractor
Makeyev Design Bureau

TORPEDOES

Total weapon load, 18 weapons.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Brick Group is a radar warning system, comprising Brick Pulp and Brick Spit, both of which have rotating antennas housed in small radomes.

Direction-finding

Park Lamp: VLF/LF receiving antenna, consisting of four open loops, mounted on its own mast.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS

ELF/VLF communications with floating aerial and buoy
UHF and SHF aerials
Pert Spring Satcom antenna
Kremmny 2 IFF.

NAVIGATION

Satnav
SINS
Omega
Cod Eye radiometric sextant.

RADAR

Snoop Tray

Snoop Tray is a surface search radar, operating in I-band. As its name implies, it has a rectangular, virtually flat antenna.

SONARS

Shark Teeth

Bow-mounted, passive/active search and attack sonar, operating at low/medium frequency.

Mouse Roar

Hull-mounted, active attack, high-frequency sonar.

PROPULSION

Specifications
System: Nuclear
Reactors: 2 VM-2 pressurised water nuclear reactors
Power output: 155 MW
Steam turbines: 2 GTA-365
Power output: 27.5 MW (37,400 hp (m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

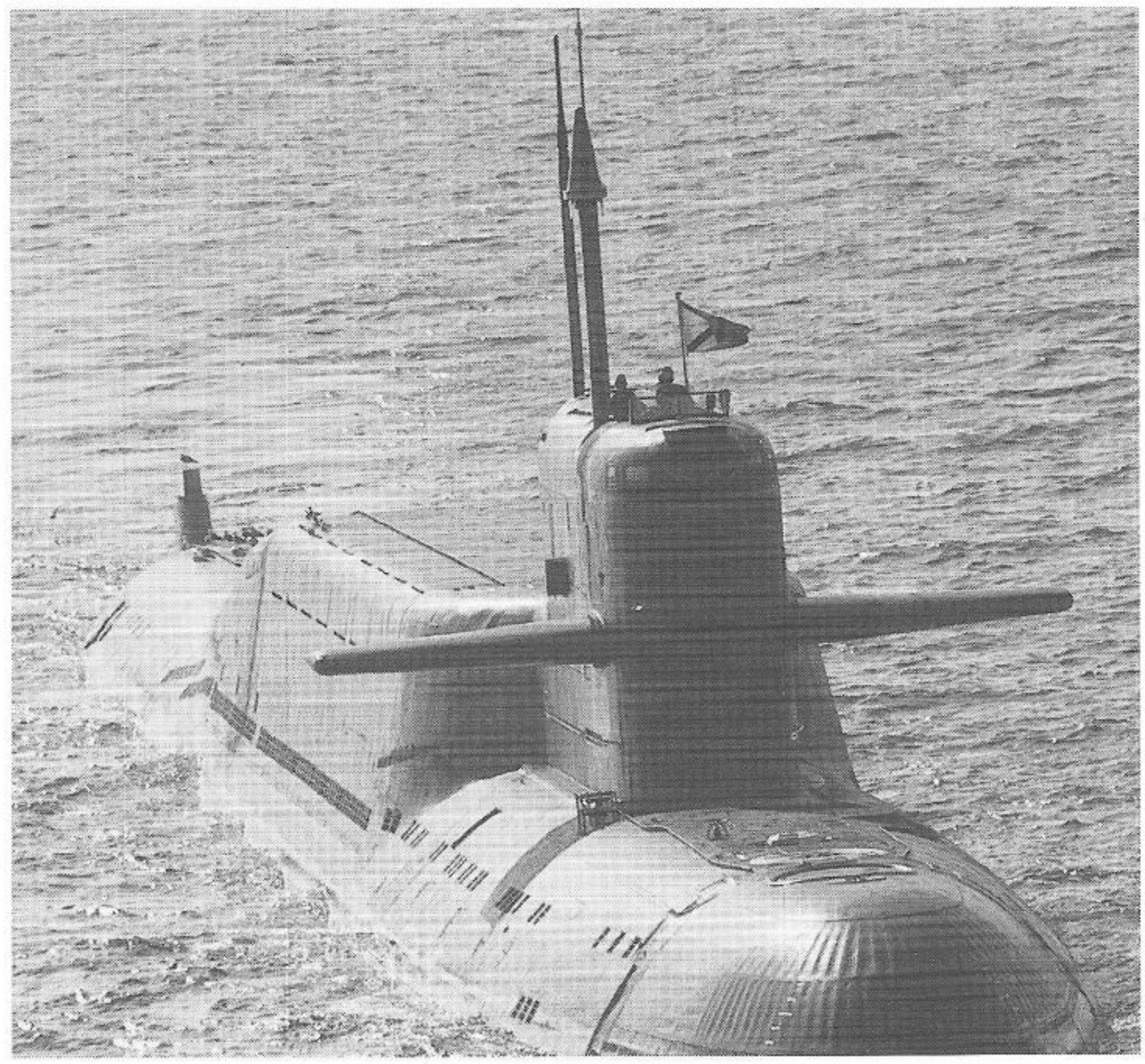
All four ships were built at Severodvinsk and completed in 1975 and 1976, but further construction was cancelled with the advent of SS-N-18 missile and the 'Delta III' class submarines.

DESIGN

Delta II was essentially a Delta I stretched by 16 m (52.50 ft), enabling it to carry four extra missile tubes and thus restore parity with Western SSBN designs. Unfortunately, as there was no extra power, it incurred a small speed penalty as a result. Apart from its greater length, the Delta II has a long smooth fairing at the after end, unlike the Delta I which has a much shorter fairing with a distinct 'step.' The outer casing has a continuous 'acoustic' coating. All are based in the Northern Fleet at Saida Guba.

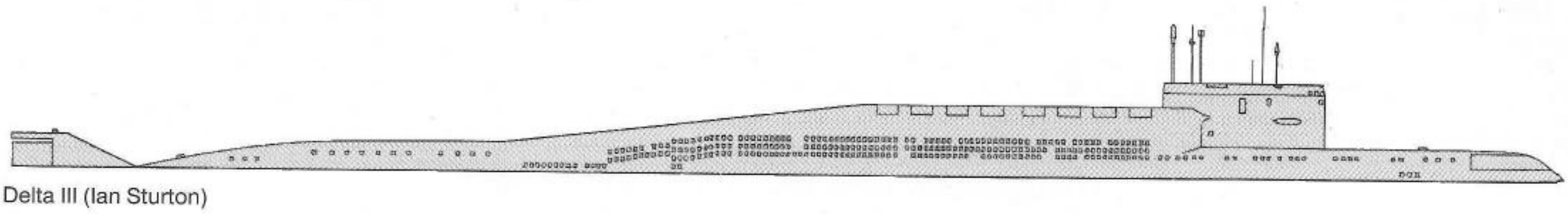
THE FUTURE

One paid off in 1994 and the remainder are expected to follow by 1997/98. They may have already been taken out of service, but confirmation is awaited.



Delta II. The complex shaping at the junction of hull, sail and missile casing causes excessive noise

DELTA III (KALMAR)



Delta III (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: Russia
Designation: *Podvodnaya Lodka Atomnaya Raketnaya Ballisticheskaya* (PLARB)

Class: DELTA III (KALMAR) (Type 667BDR)

Built: 14
Active: 13

Building: 0
Proposed: 0

Displacement:
surfaced: 8,940 t
submerged: 11,450 t
Length: 160 m overall; 152 m waterline (524.9 ft; 498.7 ft)

Beam: 12 m (39.4 ft)
Draught: 8.7 m (28.5 ft)

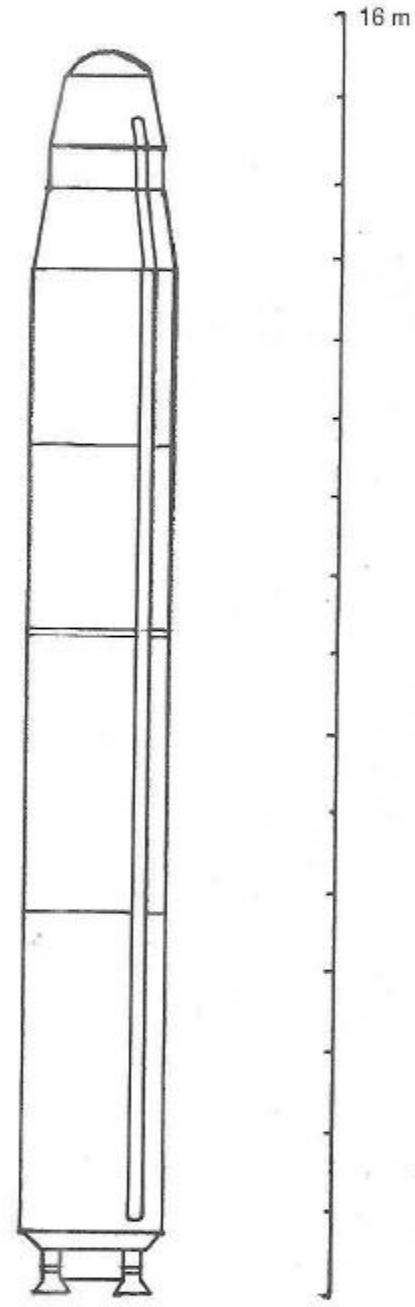
Speed, submerged: 24 kts
Diving depth: 300 m (1,000 ft)

Complement: 130

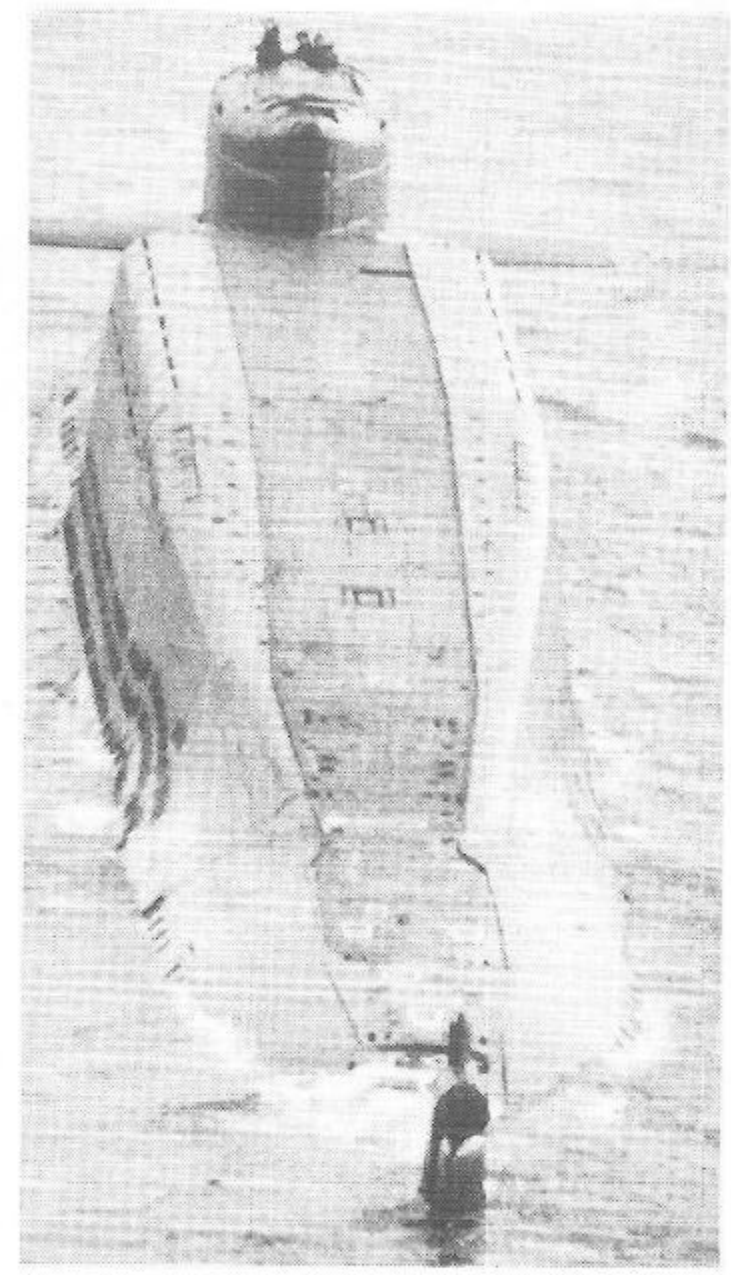
SUBMARINES

K 441	K 424	K 449	K 455
K 490	K 487	K 44	K 496
K 506	K 211	K 223	K 180
K 129			

K441 completed Dec 1976
K424 completed 1977
K449 completed 1977
K455 completed 1978
K490 completed 1978
K487 completed 1978
K44 completed 1979
K496 completed 1979
K506 completed 1979
K211 completed 1980
K223 completed 1980
K180 completed 1980
K129 completed 1981



SS-N-18



Delta III. Note towed array dispenser tube atop the rudder (US Navy)

WEAPONS SYSTEMS

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBM)

SS-N-18 (RSM-50)

Sixteen SS-N-18 (RSM-50; Volna) each with three MIRV warheads. SS-N-18 is a two-stage, liquid propellant, intercontinental-range, ballistic missile, with a post-boost vehicle (PBV) which is deployed only in 'Delta III' class SSBNs. Three versions are known to exist — Mod 1 (three 200 kT MIRVs; Mod 2 (single RV); and Mod 3 (up to seven MIRVs), with IOCs of 1977, 1978 and 1979, respectively — but in 1991 the Russians downloaded all missiles to three RVs.

Specifications

Length: 15.60 m (51.2 ft)
Body diameter: 1.80 m (5.90 ft)
Launch weight: 3,500 kg (7,716 lb)

Guidance: Inertial plus stellar reference update, computer-controlled PBV
Propulsion: 2-stage liquid plus PBV
Accuracy — (circular area probale (cep): 0.48 n miles (900 m)
Throw weight: 1,650 kg (3,638 lb)

	Mod 1	Mod 2	Mod 3
Payload	3 × MIRV	Single RV	7 × MIRV
Each RV	200 kT	450 kT	100 kT
Range	3,500 n miles (6,500 km)	4,320 n miles (8,000 km)	3,500 n miles (6,500 km)

Manufacturer/Contractor

Makeyev Design Bureau

TUBES

Four 533 mm (21 in); two 406 mm (16 in).

TORPEDOES

Total weapon load, 18 weapons.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Brick Group is a radar warning system, comprising Brick Pulp and Brick Spit, both of which have rotating antennas housed in radomes.

Direction-finding

Park Lamp: VLF/LF receiving antenna, consisting of four open loops, mounted on its own mast.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Nothing known.

COMMUNICATIONS

ELF/VLF communications with floating aerial and buoy
UHF and SHF aerials
Pert Spring Satcom antenna
Kremmny 2 IFF.

NAVIGATION

Satnav
SINS
Omega
Cod Eye radiometric sextant.

RADAR

Snoop Tray

Snoop Tray is a surface search radar, operating in I-band. As its name implies, it has a rectangular, virtually flat antenna.

SONARS

Shark Teeth

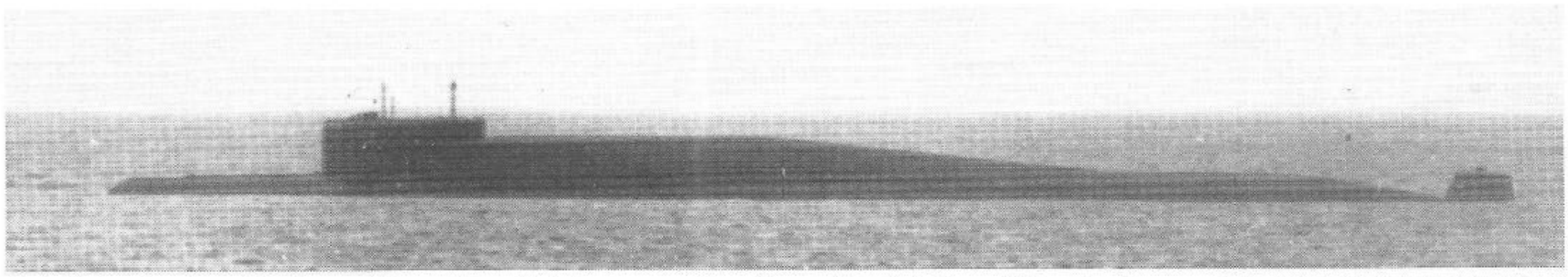
Bow-mounted, passive/active search and attack sonar, operating at low/medium frequency. This sonar is designated 'Rubikon' by the Russian Navy and is similar to that fitted in early 'Victor' class SSNs.

Mouse Roar

Hull-mounted, active attack, high-frequency sonar.

Pelamida

Towed array; passive search; very low frequency (VLF).



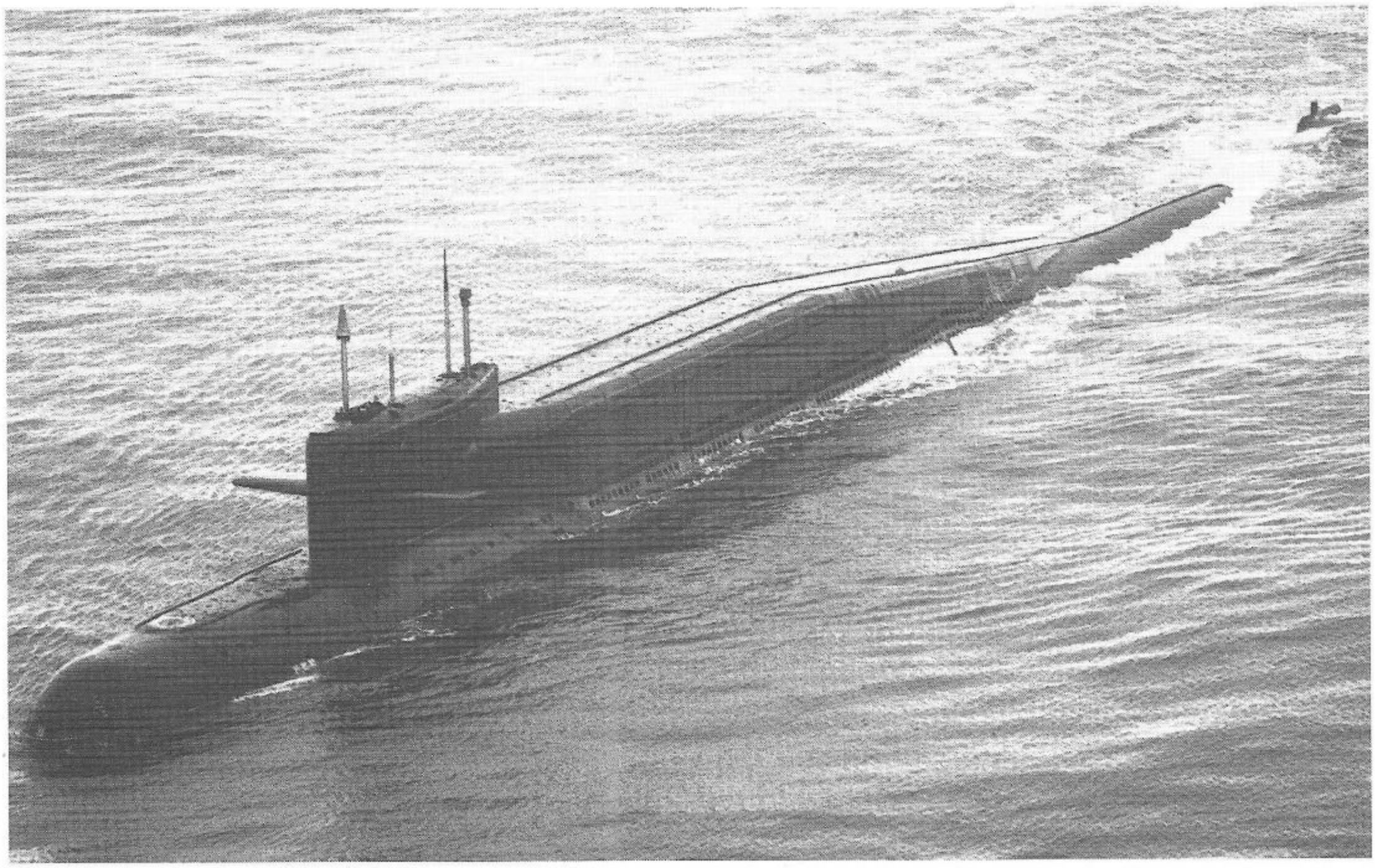
Delta III showing the original form of the rudder, which has been replaced in most boats by the addition of a dispenser tube for the Pelamida towed array

PROPULSION

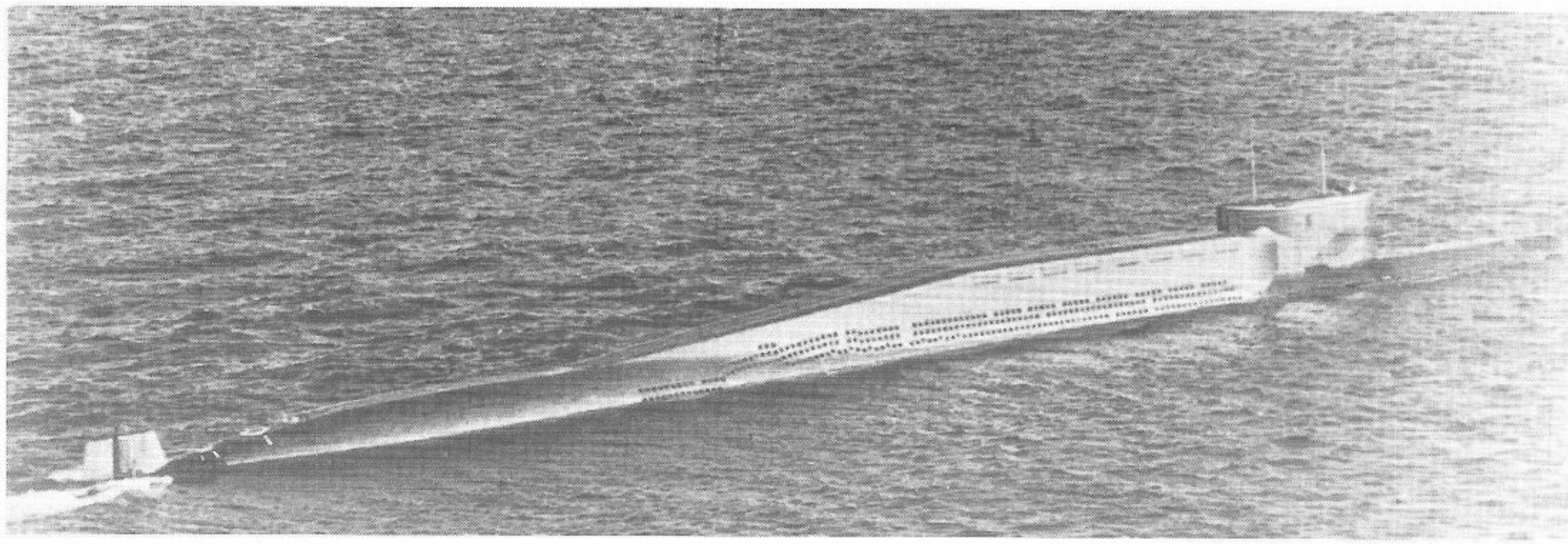
Specifications
System: Nuclear
Reactors: 2 VM-4 pressurised water nuclear reactors

Output power: 160 MW
Steam turbines: 2

Output power: 27.5 MW (37,400 hp (m))
Shafts: 2



Delta III. Note the higher casing than Delta I and Delta II, which is due to the greater length of the SS-N-18 missile



Delta III; an early ship without the towed array

FURTHER INFORMATION

SUBMARINE PROGRAMME

These 14 SSBNs were all built at Severodvinsk 402 shipyard, with K 441, the first of class, being laid down in 1975, launched in 1976, and commissioned later that same year. The others followed until the fourteenth and last entered service in 1981.

MISSILE PROGRAMME

Development of the SS-N-18 began 1968 and the missile was first tested from land-based launch sites in 1975 and from a submarine in November 1976, with long-range tests into the Pacific in late 1978. The missile has many similarities with the SS-N-8, from which it may have been derived, but it has a more sophisticated guidance system and was the first Soviet missile to carry MIRVed warheads. The Russians announced in 1991 that all SS-N-18 missiles had been downloaded to three RVs in MIRV configuration.

DESIGN

The Delta III is the same length as its predecessor, the Delta II, but the missile casing is 1.25 m (4.1 ft) higher to house the SS-N-18, which is 0.6 m (1.97 ft) longer than the SS-N-8. The outer casing has a continuous acoustic coating but is less streamlined and has more free flood holes than the Delta II.

MODERNISATION

SS-N-23 Skiff has been retrofitted in some of this class, but the number involved is not yet known. Also the dispenser tube on the after fin has been fitted to most of the class.

OPERATIONAL

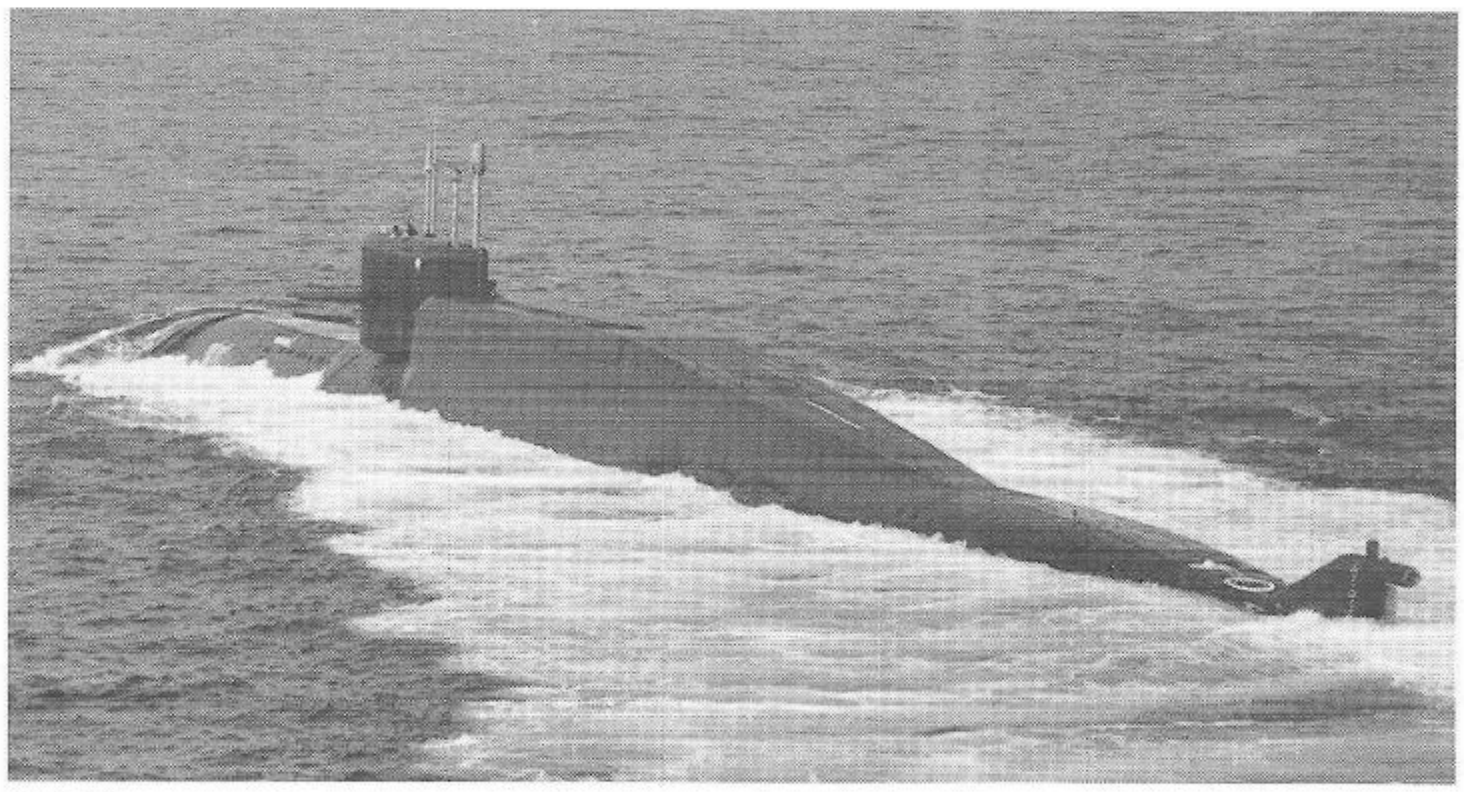
Nine of the class are based in the Pacific at Rybachy and four in the Northern Fleet at Saida Guba.

In 1991 the Russians declared that there was a total of 224 missiles operational, with a further 100 missiles in storage. Spare missiles were stored at the operational bases, at Pavlovskoye, Okolnya and Revna and there was a single SS-N-18 missile at the Pasino conversion/elimination facility.

THE FUTURE

One of the numerous current proposals for commercial 'conversions' of military equipment is the use of a Delta III as a launch platform for satellites, using SS-N-18 rockets, renamed 'Volnya'. These would be capable of placing a 130 kg (287 lb) payload into a 250 km circular orbit.

Following the START 1 and 2 agreements it is expected that some SS-N-18s will be removed from service during the 1990s, but by December 1996 only one ship in the class — K 433 — had had its missile tubes removed and been converted to carry a Deep-Sea Rescue Vehicle (DSRV).



Delta III

DELTA IV (DELFIN)

GENERAL SPECIFICATIONS

Operator: Russia
Designation: *Podvodnaya Lodka Atomnaya Raketnaya Ballisticheskaya* (PLARB)

Class: DELTA IV (DELFIN) (Type 667BDRM)

Built: 7
Active: 7

Building: 0
Proposed: 0

Displacement:
surfaced: 10,800 t
submerged: 13,500 t
Length: 166 m overall; 158 m waterline (544.6 ft; 518.4 ft)

Beam: 12 m (39.4 ft)
Draught: 8.7 m (28.5 ft)

Speed, submerged: 24 kts
Diving depth: 300 m (1,000 ft)
Complement: 130

SUBMARINES

K 51

Builder	Severodvinsk Shipyard, Russia
Laid down	Feb 1984
Launched	Jan 1985
Commissioned	Dec 1985

K 84

Builder	Severodvinsk Shipyard, Russia
Laid down	Sep 1984
Launched	Nov 1985
Commissioned	Dec 1986

K 64

Builder	Severodvinsk Shipyard, Russia
Laid down	Nov 1985
Launched	Dec 1986
Commissioned	Feb 1988

K 114

Builder	Severodvinsk Shipyard, Russia
Laid down	Dec 1986
Launched	Sep 1987
Commissioned	Jan 1989

K 117

Builder	Severodvinsk Shipyard, Russia
Laid down	Sep 1987
Launched	Sep 1988
Commissioned	Mar 1990

K 18

Builder	Severodvinsk Shipyard, Russia
Laid down	Sep 1988
Launched	Nov 1989
Commissioned	Sep 1991

K 407

Builder	Severodvinsk Shipyard, Russia
Laid down	Nov 1989
Launched	Jan 1991
Commissioned	20 Feb 1992

WEAPONS SYSTEMS

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBM)

SS-N-23 (Russia = RSM-54 Shetal) (NATO = Skiff)

Sixteen SS-N-23 submarine-launched, liquid-propelled, MIRV capable, ballistic missiles. The accuracy is estimated at 900 m, indicating that stellar sensing is used for in-flight position correction. The missile was originally believed to carry ten warheads in an MIRV configuration, but the START agreement only allocates four RVs and hence it is assumed that the 10 RV version was never tested.

Specifications

Length: 16.80 m (55.12 ft)
Body diameter:
first stage: 1.90 m (6.23 ft)
second stage: 1.50 m (4.92 ft)
Launch weight: 40,300 kg (88,845 lb)
Payload: 4 RVs in MIRV configuration
Warhead: 100 kT nuclear each
Guidance: Inertial plus stellar reference update; computer-controlled PBV
Propulsion: 3-stage liquid, plus PBV
Range: 4,481 n miles (8,300 km)
Accuracy — circular error probable (cep): 0.27 n miles (500 m)
Throw weight: 2,800 kg (6,173 lb)

Manufacturer/Contractor

Makeyev Design Bureau

TUBES

Four 533 mm (21 in).

TORPEDOES

The Delta IV also carries conventional 533 mm (21 in) torpedoes, the only limit being a maximum of 18 tube-launched weapons (torpedoes and SS-N-15).

SS-N-15 (NATO = Starfish)

SS-N-15 (Starfish) long-range anti-submarine weapon system is believed to be similar in shape to SUBROC, having a long, slim cylinder with small, retractable fins and a booster rocket at the end. SS-N-15 is associated with a low-frequency, bow-mounted, active/passive sonar system with 6 m diameter array (NATO = Shark Teeth). The weapon is loaded into a standard 533 mm torpedo tube and then launched in the same way as a torpedo. The weapon travels horizontally until it has cleared the submarine, when the rocket motor ignites and drives it to the surface and on into the atmosphere; it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-15 warhead is either a 200 kT nuclear depth charge or a Type 40 lightweight torpedo. Note that under current international agreements, nuclear warheads would not be carried at sea, although the capability, of course, remains.

Specifications

SS-N-15
Length: 6.5 m (21.33 ft)
Diameter: 533 mm (21 in)
Wing span: n/k
Weight: 1,800 kg (3,968 lb)
Range: 24-27 n miles (45-50 km)
Speed: n/k
Guidance: Inertial

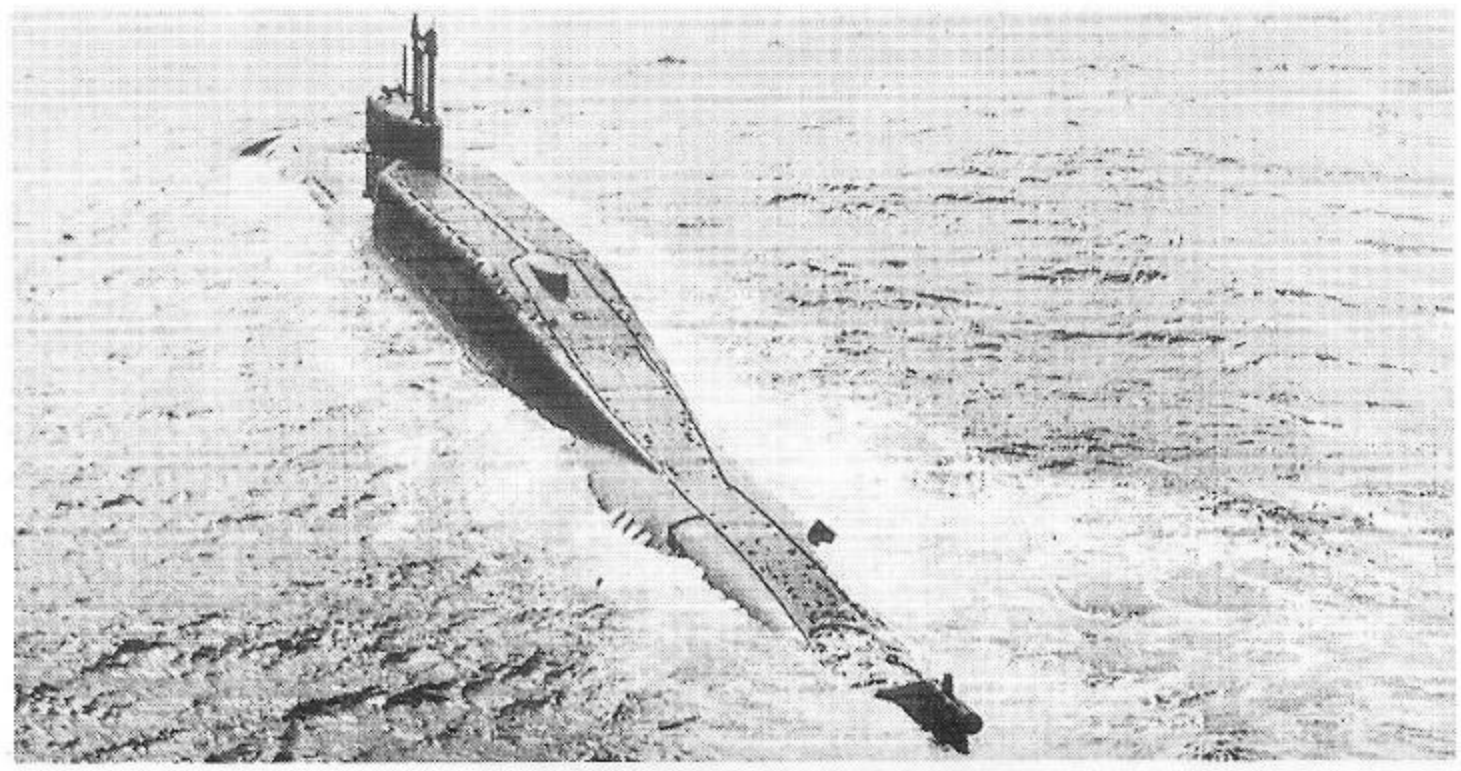
ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Brick Group is a radar warning system, comprising Brick Pulp and Brick Spit, both of which have rotating antennas housed in radomes.

Direction-finding

Park Lamp: VLF/LF receiving antenna, consisting of four open loops, mounted on its own mast.



A rare picture of a Delta IV with a missile launch tube cover open. The masts are (from left to right): Pest Spring; HF rod antenna; periscope; Park Lamp DF antenna; Snoop Tray radar; and Brick Pulp ESM

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS

ELF/VLF communications with floating aerial and buoy UHF and SHF aerials.

RADAR

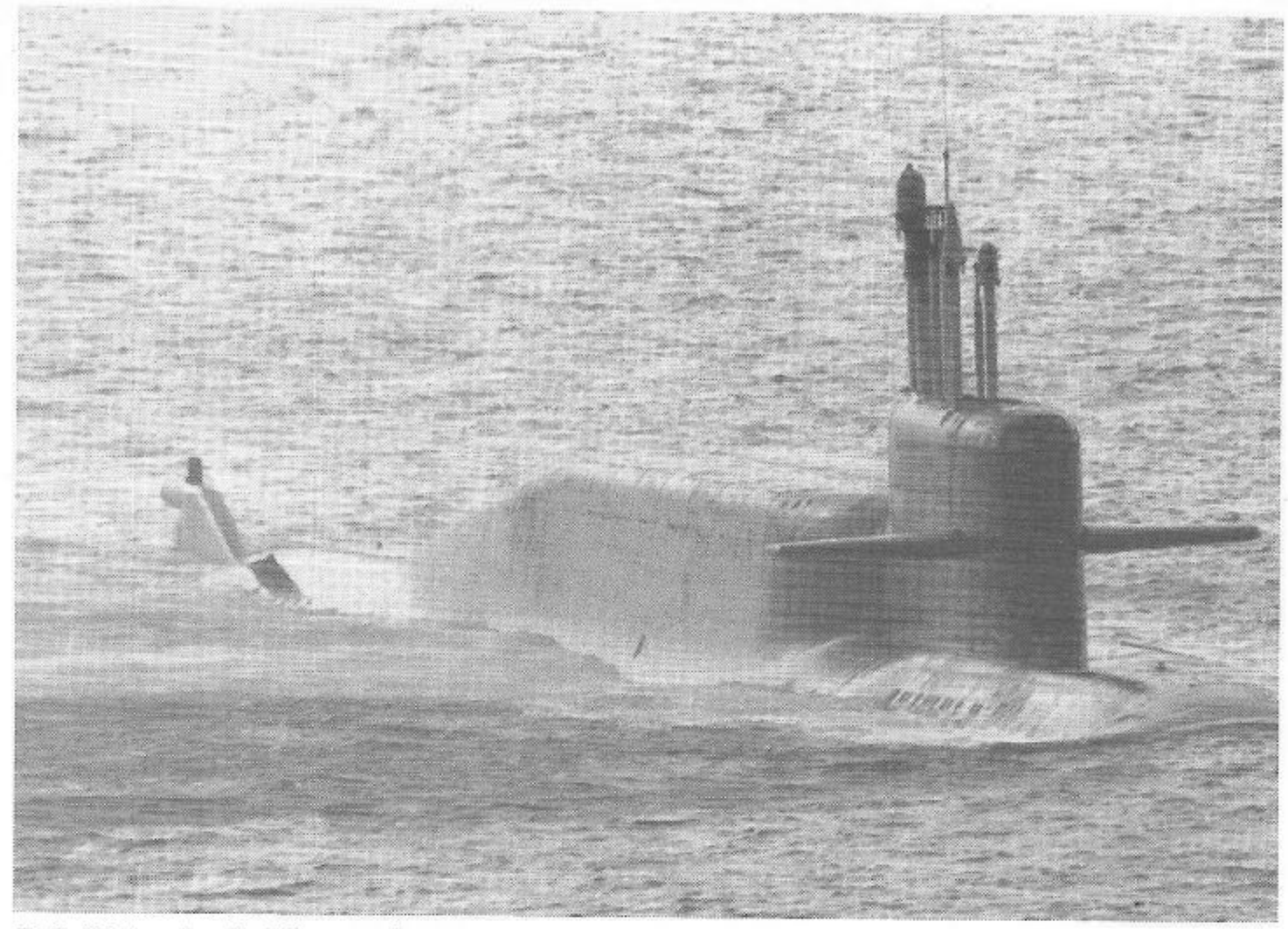
Snoop Tray
Snoop Tray is a surface search radar, operating in I-band. As its name implies, it has a rectangular, virtually flat antenna

SONARS

Shark Gill
The sonar suite has the Russian name Skat-2 and has a large spherical array designated MGK-200 (NATO – Shark Gill).

Mouse Roar
Hull-mounted, active attack, high-frequency sonar.

Pelamida
Pelamida is a flank and towed passive search sonar, operating at very low frequencies.



Delta IV showing its full array of masts and the dispenser tube for the towed sonar array

PROPULSION

Specifications
System: Nuclear
Reactors: 2 VM-4 pressurised water reactors

Power output: 180 MW
Steam turbines: 27.5 MW (37,400 hp (m))
Shafts: 2

FURTHER INFORMATION

SUBMARINE PROGRAMME

The Delta IV, constructed in parallel with the Typhoon, was built for a different mission, being designed to operate in one of the two SSBN bastions for relatively early use in a strategic exchange in the first wave of a second strike. The first of class was launched in February 1984 and commissioned later that year. All were built at Severodvinsk and launched at the rate of about one per year, until the programme ended in late 1990 with the seventh hull, K 407. The class is considered to be a great success by the Russian Navy and will probably form the basis of Russia's new generation of SSBN.

MISSILE PROGRAMME

The SS-N-23 'Skiff' (Russian designation RSM-54; Shetal) is the natural successor to SS-N-18 and indicates that the Russian Navy continues to prefer liquid- to solid-fuelled missiles. This could be because of their extensive experience and confidence in their safety, but on the other hand it could be due to the disappointing experience with the solid-fuelled SS-N-17 and SS-N-20. The SS-N-23 began testing in 1983 and became operational with the 'Delta IV' class in 1985/86. In 1991 the Russian Navy confirmed that 112 missiles were deployed in seven Delta IV, all of which were based at Olenya, with a further 50 missiles in storage at Okolnya and Revna, and the picture is still believed to be accurate. Some SS-N-23s are being retrofitted into Delta IIIs to replace SS-N-18s, but there is no confirmation of the numbers, as yet. As with Delta III/SS-N-18 (see Delta III entry) the Makeyev design bureau is proposing that SS-N-23 missiles should be used as satellite launch vehicles, using either converted 'Delta 3' submarines or floating barge launchers. Such a system would be capable of placing a 550 kg (1,200 lb) payload into a 432 n mile (800 km) circular orbit or 2,000 kg (4,410 lb) into low earth orbit. The modified SS-N-23 missile, to be known as Surf, is believed to comprise the first stage of the SS-N-20 'Sturgeon' mated to all three stages of SS-N-23, and is being marketed together with modified SS-N-8 and SS-N-18 liquid propellant SLBMs as space vehicle launchers.

DESIGN

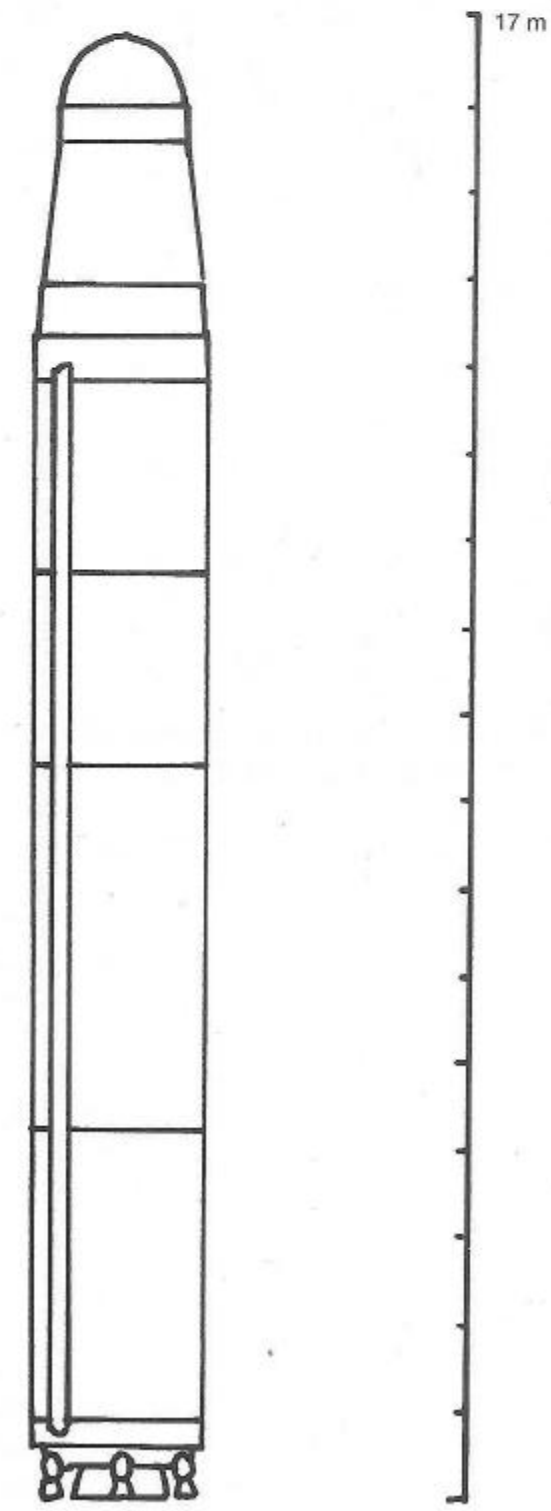
The Delta IV is generally similar to the Delta III, but is 9 m (29.52 ft) longer and has a number of relatively minor differences. The tail empennage is quite different from earlier classes, with a shorter after fin capped by a slim tubular dispenser for a buoyant communications wire aerial or sonar thin line towed array. The other distinguishing feature (although not, apparently, fitted in all ships of the class) is the pressure-tight fitting on the after end of the missile tube housing, which may be a TV camera to monitor communications buoy and wire retrieval operations. The outer casing has a continuous acoustic coating and fewer free flood holes than the Delta III.

OPERATIONAL

A modified and more accurate version of SS-N-23 was tested at sea in 1988, bringing the cep (circular area probable) down from 900 to 500 m (2,950 to 1,640 ft). All are based in the Northern Fleet at Olenya.

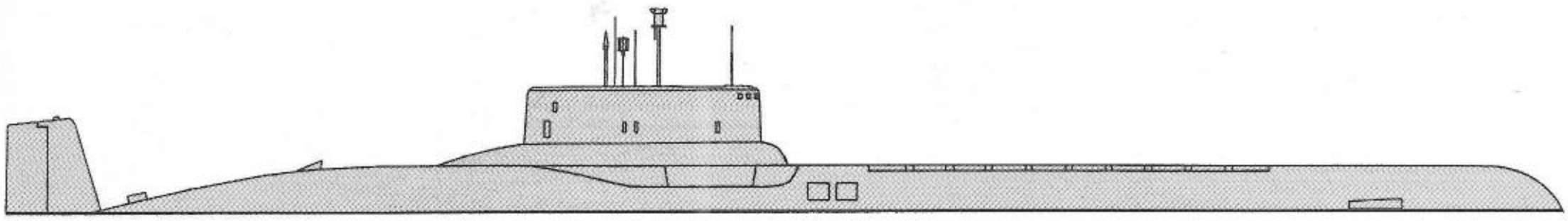
THE FUTURE

The SS-NX-26 SLBM programme is expected to result in a successor to the SS-N-23, possibly for use in the follow-on to the Delta IV boats.



SS-N-23

TYPHOON



Typhoon (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: Russia
Designation: *Podvodnaya Lodka Atomnaya Raketnaya Ballisticheskaya* (PLARB)

Class: TYPHOON (AKULA) (Type 941)

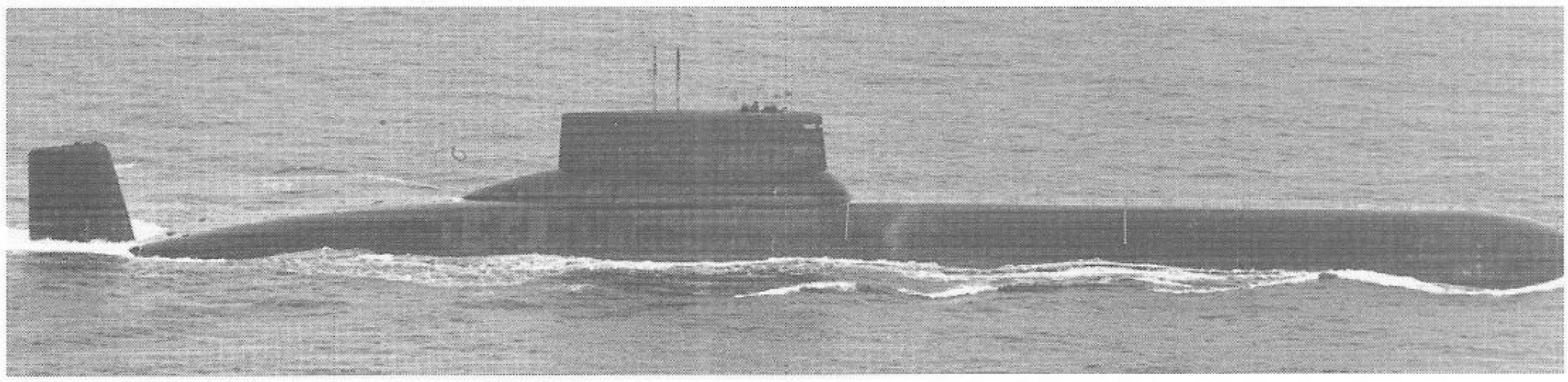
Active: 6
Building: 0
Proposed: 0

Displacement:
surfaced: 21,500 t
submerged: 26,500 t
Length: 171.5 m overall; 165 m waterline (562.7 ft; 541.3 ft)
Beam: 24.6 m (80.7 ft)
Draught: 13 m (42.7 ft)

Speed, submerged: 26 kts
Diving depth: 300 m (1,000 ft)

Complement: 175 (55 officers) (2 crews)

SUBMARINES



Typhoon

TK 208	
Builder	Severodvinsk Shipyard, Russia
Laid down	3 Mar 1977
Launched	23 Sep 1980
Commissioned	12 Dec 1981

TK 12	
Builder	Severodvinsk Shipyard, Russia
Laid down	27 Apr 1982
Launched	17 Dec 1983
Commissioned	Nov 1984

TK 17	
Builder	Severodvinsk Shipyard, Russia
Laid down	24 Feb 1985
Launched	Aug 1986
Commissioned	6 Nov 1987

TK 202	
Builder	Severodvinsk Shipyard, Russia
Laid down	1 Oct 1980
Launched	26 Sep 1982
Commissioned	28 Dec 1983

TK 13	
Builder	Severodvinsk Shipyard, Russia
Laid down	17 Jan 1984
Launched	21 Feb 1985
Commissioned	29 Dec 1985

TK 20	
Builder	Severodvinsk Shipyard, Russia
Laid down	6 Jan 1987
Launched	Jun 1988
Commissioned	4 Sep 1989

WEAPONS SYSTEMS

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBM)

SS-N-20 (RSM-52) (NATO = Sturgeon)

Twenty SS-N-20 (Russian designation: RSM-52) submarine-launched, three-stage, solid propellant, MIRV capable, intercontinental-range ballistic missiles. SS-N-20, the second Russian solid-fuelled rocket, began development in 1972 with the first flight tests taking place in January 1980. There was a long run of failures until two successful tests were reported in 1981 and, in October 1982, a simultaneous launch of four missiles was reported.

The missile carries a payload of 10 RVs in an MIRV configuration. SS-N-20 entered service in 1982 and is currently deployed in six 'Typhoon' class boats, with 120 missiles in service in 1991, plus a further 31 missiles at Nenoska, SS-N-20 test site. All six Typhoon boats were based at Nerpichya in Russia. A modified version of the missile is reported to be in development. It is also reported that the Russians are proposing to download SS-N-20 missiles to six or four RV under the START 2 agreements.

Specifications

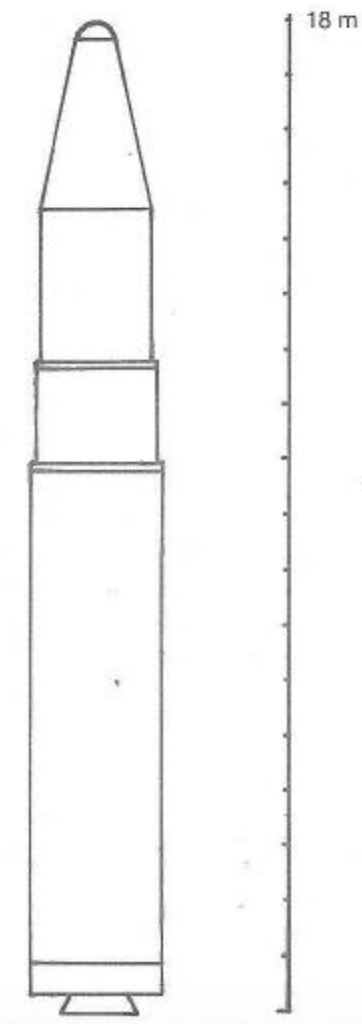
Length: 18.00 m (59.06 ft)
Body diameter:
1st-stage: 2.40 m (7.87 ft)
2nd-stage: 2.30 m (7.55 ft)
Launch weight: 84,000 kg (185,220 lb)
Payload: 10 RVs in MIRV configuration
Warhead: 100 kT nuclear each
Guidance:
missile: inertial plus stellar reference update
post-boost vehicle: computer-controlled
Propulsion: 3-stage solid plus PBV
Range: 4,500 n miles (8,300 km)
Accuracy — circular error probale (cep): 0.27 n miles (500 m)
Throw weight: 2,500 kg (5,511 lb)

Manufacturer/Contractor

Makeyev Design Bureau

SS-N-15 (NATO = Starfish)/SS-N-16 (NATO = Stallion)

SS-N-15 (Starfish) and SS-N-16 (Stallion) are two separate but complementary long-range anti-submarine weapon systems and no photographs or drawings of either have been published, although they are believed to be similar in shape to SUBROC, having a long, slim cylinder with small, retractable fins and a booster



SS-N-20

rocket at the end. SS-N-15 is associated with a low-frequency, bow-mounted, active/passive sonar system with 6 m diameter array (NATO = Shark Teeth), while SS-N-16 has a similar system (NATO = Shark Gill), which is integrated with a passive, towed-array sonar. The weapon is loaded into a standard torpedo tube (533 mm for SS-N-15; 650 mm for SS-N-16) and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere, where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern.

The SS-N-15 warhead is a 200 kT nuclear depth charge which sinks to the optimum depth and then detonates; the lethal radius is some 2.5 to 5 n miles (5 to 10 km). The SS-N-16 payload is usually an E45-75A lightweight torpedo with a range of 8.1 n miles (15 km) at 30 kts. The torpedo has both passive and active sonar sensors and a warhead of either 100 kg (some sources say 90 kg) high explosives (SS-N-16A Veder) or a nuclear warhead of undetermined power (SS-N-16B Vodopod).

Note that under current international agreements, nuclear warheads would not be carried at sea, although the capability, of course, remains.

Specifications

SS-N-15
Length: 6.5 m (21.33 ft)
Diameter: 533 mm (21 in)
Wing span: n/k
Weight: 1,800 kg (3,968 lb)
Range: 24-27 n miles (45-50 km)
Speed: n/k
Guidance: Inertial

SS-N-16
Length: 6.7 m (21.98 ft)
Diameter: 650 mm (25.61 in)
Wing span: n/k
Weight: 1,850 kg (4,078 lb)
Range: 50 n miles (92 km)
Speed: n/k
Guidance: Inertial

SURFACE-TO-AIR MISSILES (SAM)/ SURFACE-TO-SURFACE MISSILES (SSM)

SA-N-8
There are suggestions, so far unconfirmed, that this class may have an SAM capability. Recent reports indicate that these submarines may carry SA-N-8 SAMs and SS-N-22 SSMs. The deployment of such weapons indicates a perceived need for the Typhoon to have to defend itself when it surfaces to carry out its role (see 'Further Information').

TUBES

Two 533 mm (21 in) tubes; four 650 mm (25.6 in) tubes. Total tube-launched weapons, 36.

TORPEDOES

The 'Typhoon' class also carries conventional torpedoes, the only limit being the overall total of 36 for SS-N-15, SS-N-16 and 533 mm (21 in) and 650 mm (25.6 in) torpedoes.

MINES

Mines can be carried in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Rim Hat
Rim Hat radar warning receiver consists of a number of intercept antennas mounted in a circle at the base of the Snoop Pair motor drive unit.

COMMAND AND C0NTROL SYSTEMS

COMBAT DATA SYSTEMS

Weapons system control
3R65 data control system (no details are known).

COMMUNICATIONS

Satellite communications
Pert Spring Satcom mast.

Park Lamp
VLF/LF receiving antenna, consisting of four open loops, mounted on its own mast.

VLF/ELF
Two communication buoys are fitted.

IFF
Kremmny 2.

RADAR

Snoop Pair, I/J band surface search radar antenna group consists of two antennas, which are mounted back to back at the top of a conical-shaped mount, which houses the motor driving the antenna.

SONARS

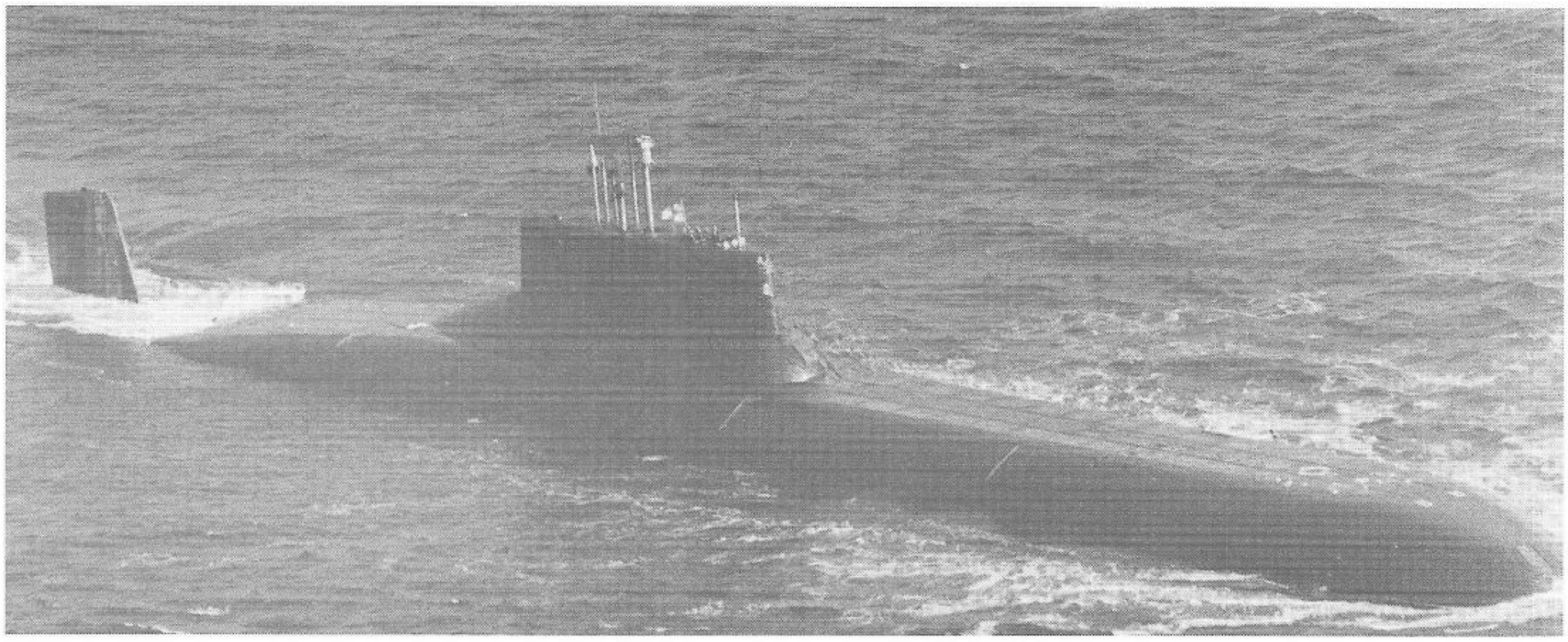
Skat sonar suite
Bow-mounted, passive/active search and attack sonar, operating at low/medium frequency.

Mouse Roar
Sail-mounted, active attack, high-frequency sonar.

NAVIGATION

Cod Eye radiometric sextant.

VLF navigation system
A VLF system is installed for under-ice operations.



Typhoon

PROPULSION

Specifications
System: Nuclear
Reactors: 2 VM-5 pressurised water (PWR) reactors
Power output: 380 MW
Turbines: 2 GT3A

Power output: 60 MW (81,600 hp(m))
Shafts: 2
Propellers: 2, shrouded
Auxiliary power: 2–800 kW diesel generators

FURTHER INFORMATION

PROGRAMME

These six ships, which were designed by Firma Rubin at St Petersburg, are the largest submarines ever built, by a very wide margin. The design caused considerable dismay in the West when its existence first became known in the early 1980s, mainly due to its huge size, but also because of the siting of the missiles forward of the sail, the purpose of which was unclear. The Typhoon's already fearsome reputation was enhanced with the announcements that the first of class had fired two missiles in 15 seconds and that it was intended primarily for under-ice operations.

The programme proceeded slowly, since these very large and complex designs took a long time to build, but has ended with the sixth hull.

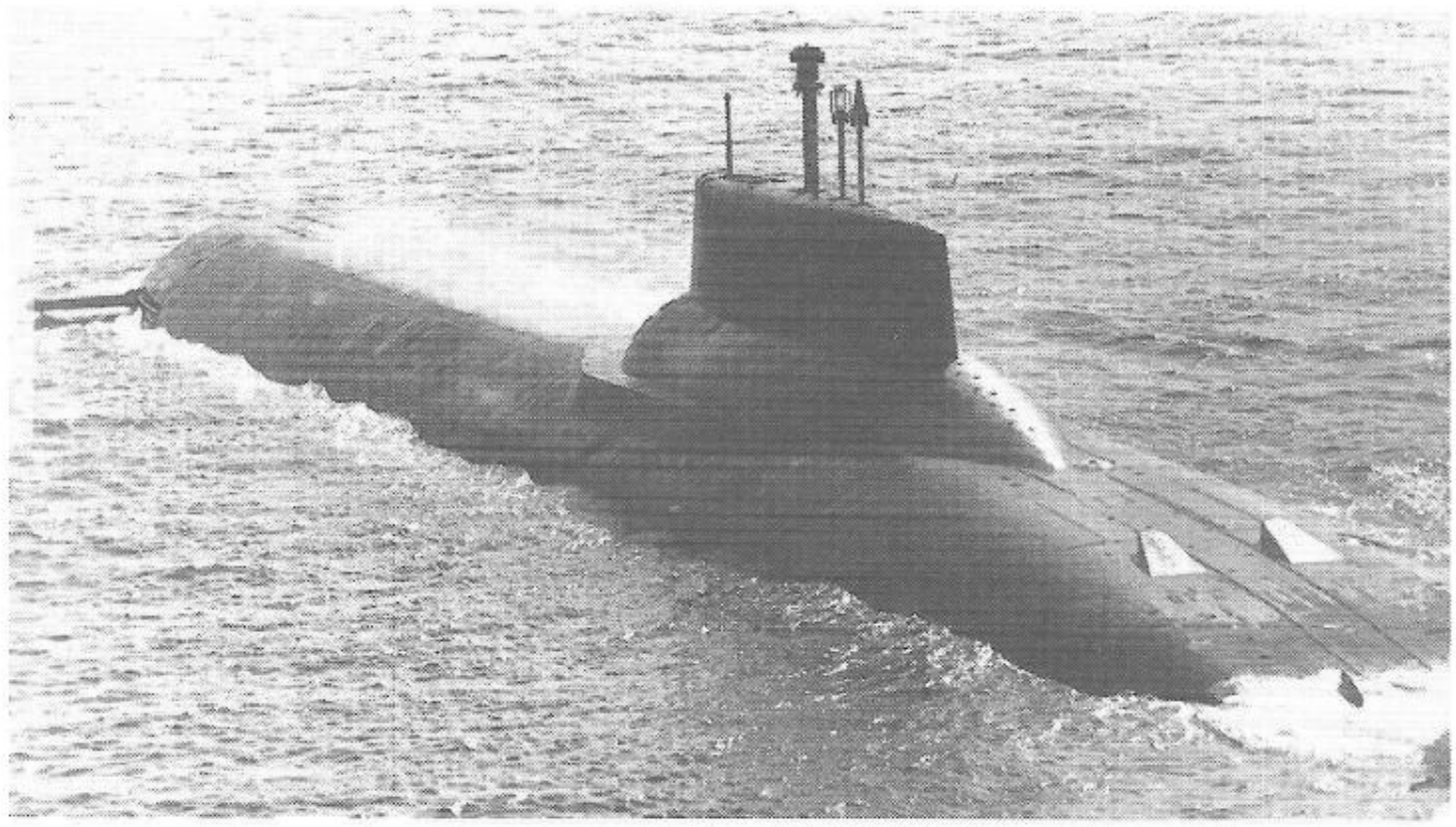
DESIGN

The design is unique, consisting of five separate but interconnected pressure vessels. The two largest are 8.5 m (27.9 ft) in diameter and run for virtually the whole length of the submarine, each containing a missile section forward and a propulsion section aft. The missile section houses ten launch tubes for SS-N-20 missiles, while the propulsion sections each accommodate one complete nuclear drive train plus an auxiliary diesel generator.

Forward is a smaller pressure hull containing the torpedo tubes (two 533 mm; four 650 mm) together with the torpedoes and SS-N-15 and SS-N-16 missiles, with the bow sonar dome attached to its forward end. The fourth pressure hull contains the command and control elements, housing the combat information centre (CIC) and communications centre, with the fin and the various masts on top. Finally, there is a smaller cylinder aft housing the steering apparatus.

These pressure hulls are surrounded by a single outer free-flood hull completely coated with anechoic Cluster Guard tiles. There is a large separation between the outer and inner hulls along the sides, giving considerable protection against attacking torpedoes.

One of several unique features of Typhoon is the siting of the missile tubes forward of the fin. The positioning of the launch tubes has enabled the designer to install a fully integrated weapons area in the bow section, leaving space abaft the fin for the provision of two



Typhoon, with extended forward hydroplanes and four masts raised: (from left to right) rod antenna; rim hat; Park Lamp; Pert Spring

nuclear reactors, one in each hull — probably needed to achieve a reasonable speed with this huge hull.

The fin configuration indicates that these submarines are intended to break through ice cover possibly up to 3 m (10 ft) thick; the retractable forward hydroplanes, the rounded hull and the shape of the fin are all related to under-ice operations.

ROLE

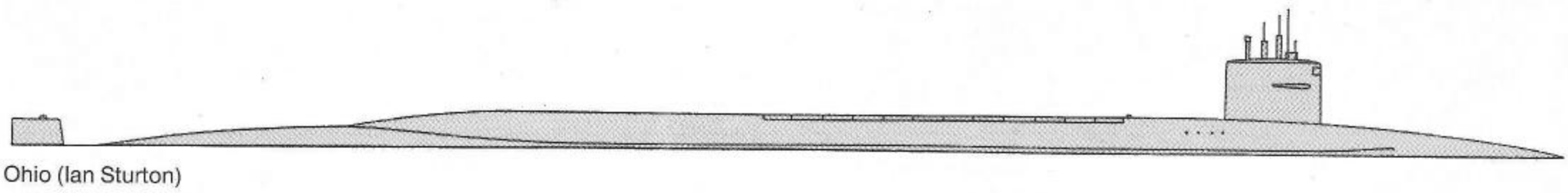
These enormous submarines were designed for a very specific mission, to provide a highly survivable platform to take part in the final phase of a protracted nuclear war. The Typhoon would sail northwards, and then submerge under the Arctic ice cap where it would lie on the bottom, sit out the nuclear exchanges and then surface through the ice-cap to launch missiles against an enemy who would probably be taking the first steps towards recovery. One of the requirements for such a mission is habitability and the Typhoon is very spacious, with facilities which include a swimming pool, a sauna and a club with a panoramic view of countryside to make the crew feel 'at home'. It is reported that endurance on peacetime patrols is 100 days, although the Typhoon was designed to remain at sea for as much as a year.

All are based in the Northern Fleet at Litsa Guba, where one was damaged by fire during a missile loading accident in 1992 but the damage has been repaired. Only two are reported to be operational in 1996.

MODERNISATION

There have been unsubstantiated reports that Russian submariners are not very happy with these submarines and the decision not to build any more after completion of the sixth has probably been taken as much on technical as financial grounds. Meanwhile, the class is being modernised in a programme, which began in 1994, to take an SS-N-20 follow-on missile (SS-N-28), which has improved accuracy. This is a very slow programme, starting with TK208, which is reported to have been out of service since 1991.

OHIO



Ohio (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: USA
Type: Nuclear-powered, ballistic missile submarine (SSBN)

Class: OHIO

Active: 17
Building: 1
Proposed: 0

Displacement:
surfaced: 16,600 t
submerged: 18,750 t
Length: 170.7 m (560 ft)
Beam: 12.8 m (42 ft)
Draught: 11.1 m (36.4 ft)

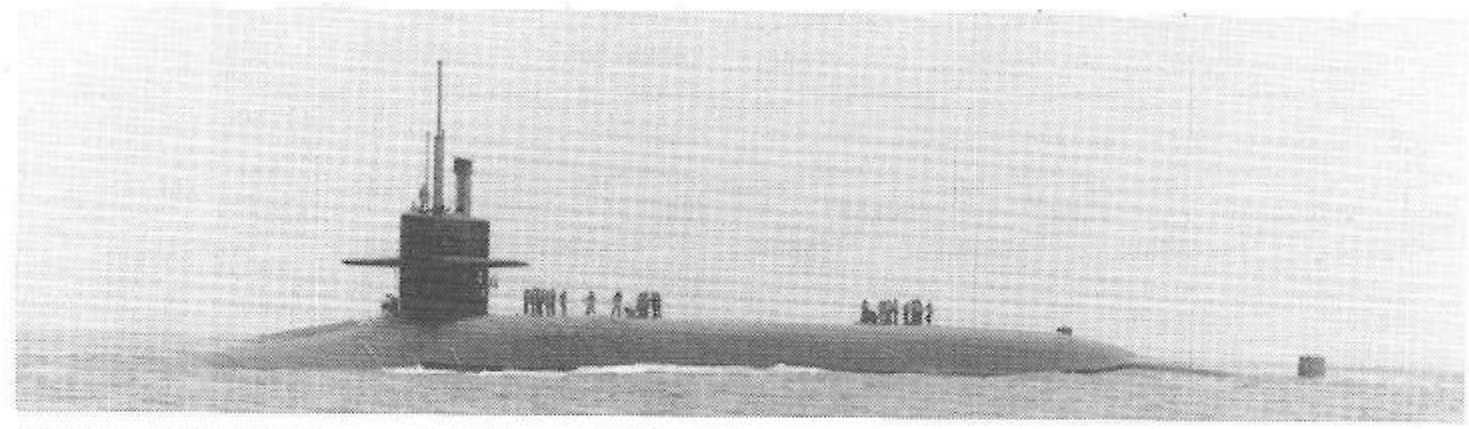
Speed, submerged: 20+ kts
Diving depth: 300 m (984 ft)

Complement: 155 (14 officers in first 6, 15 in remainder)

SUBMARINES

OHIO (SSBN 726)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 7 Apr 1979
Commissioned 11 Nov 1981

MICHIGAN (SSBN 727)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 26 Apr 1980
Commissioned 11 Sep 1982



Michigan *(SSBN 727), one of eight armed with Trident I (C4) missiles* (US Navy)

FLORIDA (SSBN 728)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 14 Nov 1981
Commissioned 18 Jun 1983

GEORGIA (SSBN 729)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 6 Nov 1982
Commissioned 11 Feb 1984

HENRY M JACKSON (SSBN 730)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 15 Oct 1983
Commissioned 6 Oct 1984

ALABAMA (SSBN 731)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 19 May 1984
Commissioned 25 May 1985

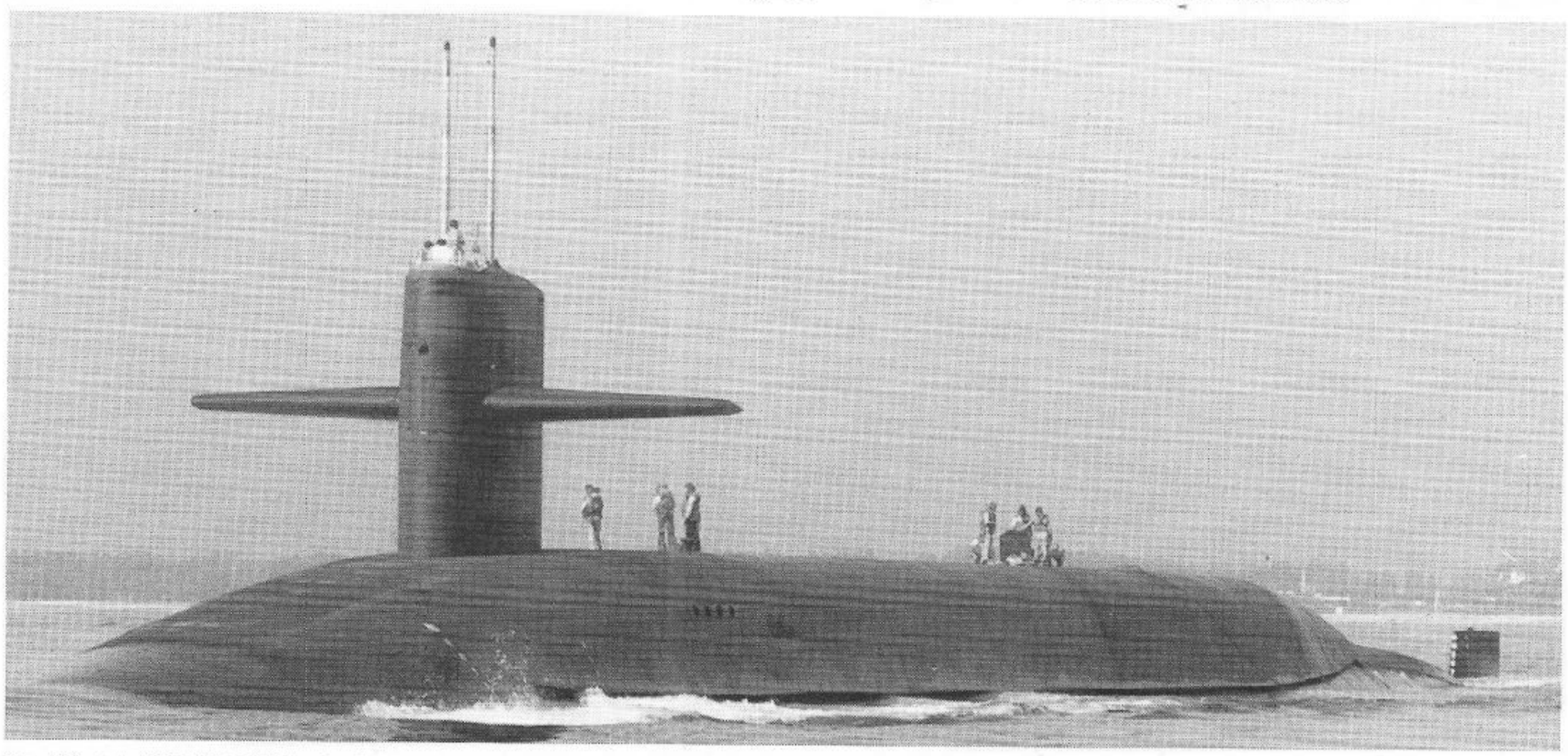
ALASKA (SSBN 732)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 12 Jan 1985
Commissioned 25 Jan 1986

NEVADA (SSBN 733)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 14 Sep 1985
Commissioned 16 Aug 1986

TENNESSEE (SSBN 734)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 13 Dec 1986
Commissioned 17 Dec 1988

PENNSYLVANIA (SSBN 735)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 23 Apr 1988
Commissioned 9 Sep 1989

WEST VIRGINIA (SSBN 736)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 14 Oct 1989
Commissioned 20 Oct 1990



West Virginia *(SSBN 736)* (Giorgio Arra)

KENTUCKY (SSBN 737)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 11 Aug 1990
Commissioned 13 Jul 1991

MARYLAND (SSBN 738)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 10 Aug 1991
Commissioned 13 Jun 1992

NEBRASKA (SSBN 739)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 15 Aug 1992
Commissioned 10 Jul 1993

RHODE ISLAND (SSBN 740)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 17 Jul 1993
Commissioned 9 Jul 1994

MAINE (SSBN 741)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 16 Jul 1994
Commissioned 29 Jul 1995

WYOMING (SSBN 742)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched 15 Jul 1995
Commissioned Aug 1996

LOUISIANA (SSBN 743)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Launched Sep 1996
Commissioned Aug 1997

WEAPONS SYSTEMS

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBM)

UGM-96 Trident I (C4)

24 Trident I (C4) SLBMs equip eight 'Ohio' class SSBNs: *Ohio* (SSBN 726) to *Nevada* (SSBN 733), both inclusive. The Trident I (C4) was required to attain 60 per cent greater range than the Poseidon, which was achieved by the use of higher-energy propellants, the addition of a third-stage motor, and the use of micro-electronics and lighter materials. The system entered service in converted 'Lafayette' class SSBNs in 1979 and in the first of the 'Ohio' class in 1981. The guidance system for the Trident C4 is both smaller and lighter than earlier models and utilises a stellar sensing unit to update the missile position and thus improve its accuracy. The fire-control system is the Mk 98, Mod 0 with a new digital fire-control computer to handle the increased computational load in providing presettings.

One of the features of the design is the 'aerospike', a telescopic rod, which extends from the missile nose on launch. Using a phenomenon known as 'supercavitation' it reduces aerodynamic drag to give the same effect as a much longer, pointed nose. This enables the designers to extend the maximum diameter of the missile forwards, thus increasing the internal volume which is available.

The missile can be launched from the submarine when either on the surface or when submerged and is ejected from the launch tube using a gas generator (analogous to the cold-launch technique of the Peacekeeper missile), with the first-stage motor igniting once the missile is clear of the surface.

Specifications

Length: 10.39 m (34.09 ft)
Body diameter: 1.88 m (6.16 ft)
Launch weight: 32,850 kg (72,420 lb)
Throw weight: 1,500 kg (3,307 lb)
Guidance: Inertial with stellar reference update
Propulsion: 3-stage solid propellant
Range: 4,000 n miles (7,400 km)
Payload: 8 Mk 4 MIRV
Warheads: W76; 100 kT nuclear each
Accuracy (circular error probable (cep)): 0.25 n miles (450 m)

Manufacturer/Contractor

Lockheed Missiles and Space Company (LMSC), Sunnyvale, California, USA.

UGM-133 Trident D5

24 Trident II (D5) missiles equip 10 'Ohio' class SSBNs: from *Tennessee* (SSBN 734) to the final ship to be built, *Louisiana* (SSBN 743), both inclusive. The D5 development programme started in 1975, primarily in order to improve the accuracy of the warheads and the resulting system has, for the first time, given the US Navy's SSBN force a 'hard target kill' capability. The practical payload limit, depending upon the range required, is 12 MIRVs, but implementation of the START I limits reduced this to eight, while START II will reduce it further to four. Re-entry vehicles can be Mk 4 with W76 warheads (100 kT each), or Mk 5 RVs with W88 warheads (475 kT each). A total of 400 W88 warheads has been produced and the remainder of the force is expected to be fitted with the W76 warheads.

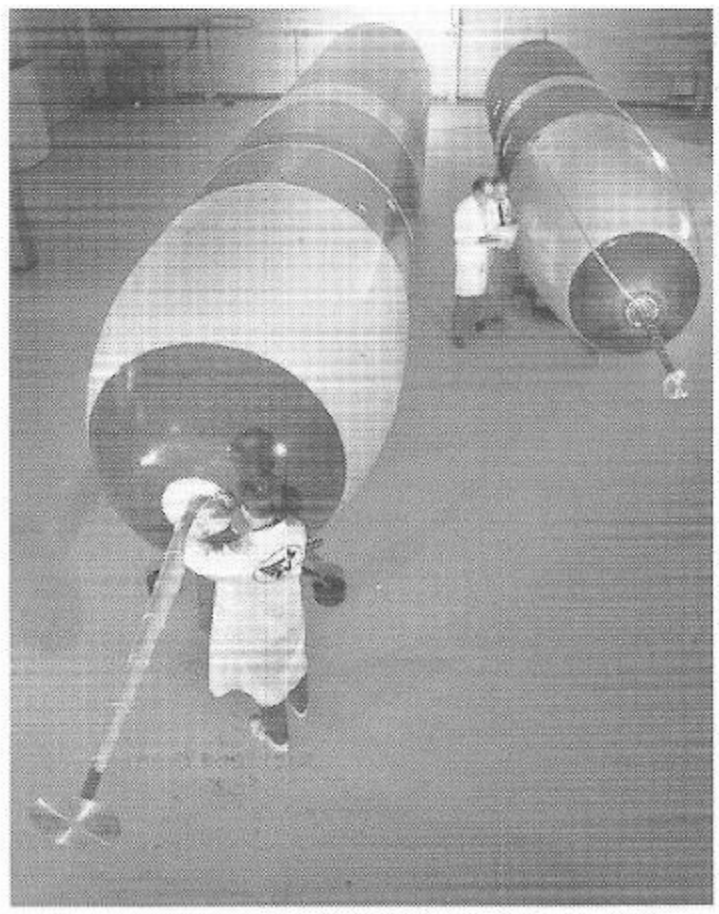
Specifications

Length: 13.42 m (44.03 ft)
Body diameter: 2.11 m (6.92 ft)
Launch weight: 59,090 kg (130,293 lb)
Payload:
Theoretical max: 16 RVs
Max (START I): 8 Mk 4/5 RVs
Max (START II): 4
Warheads: W76 at 100 kT or W88 at 475 kT
Guidance: Inertial with stellar reference update
Propulsion: 3-stage solid propellant
Range: 6,500 n miles (12,000 km)
Accuracy — circular error probable (cep): 0.048 n miles (90 m)
Throw weight: 2,800 kg (6,172 lb)

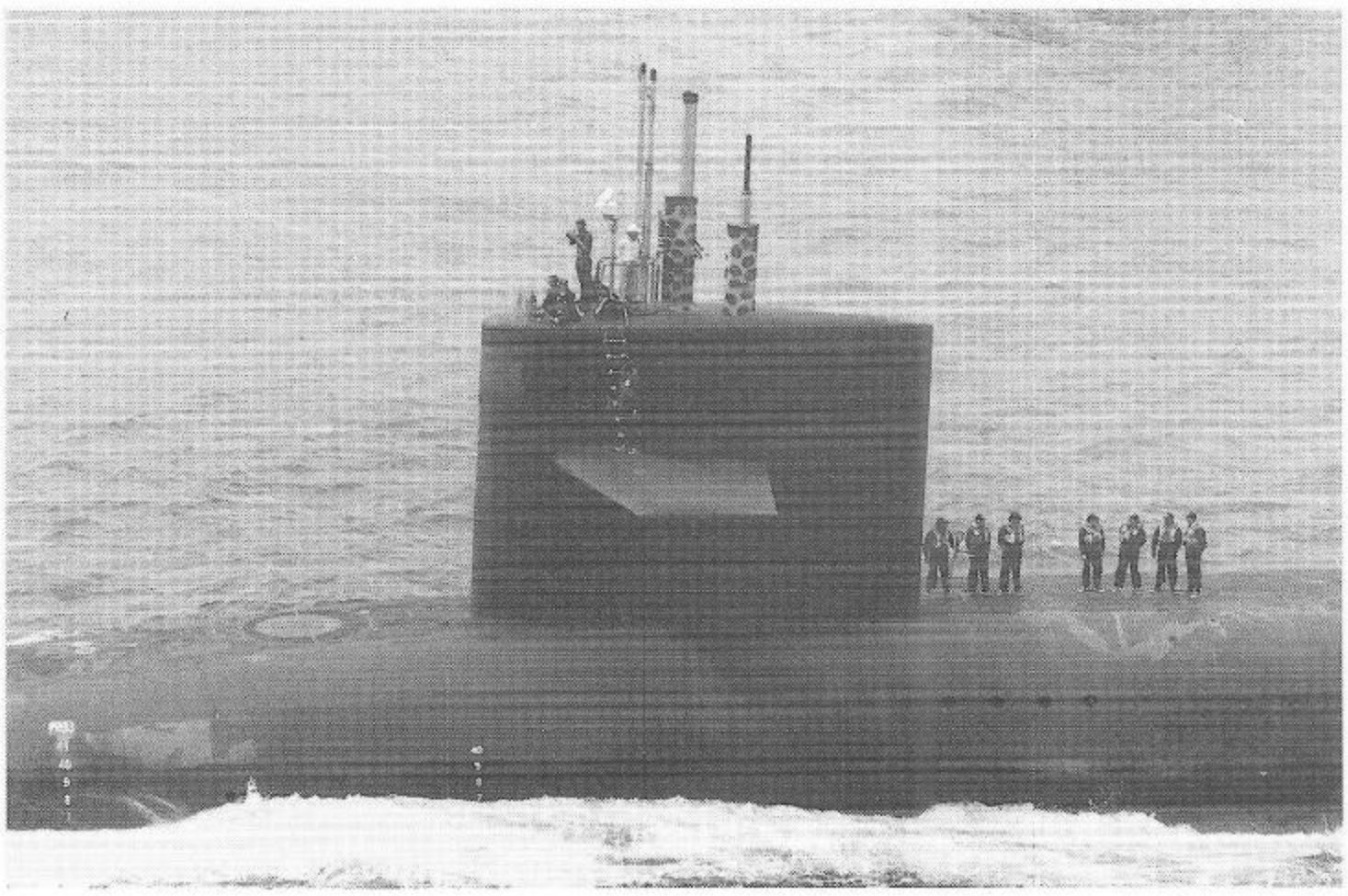
Manufacturers/Contractors

Lockheed Missiles and Space Company (LMSC), Sunnyvale, California, USA (prime).
Lockheed Martin (second source).

Trident II (D5) blast off following launch from an 'Ohio' class SSBN (Lockheed)



The difference in size between Trident II (D5) on the left and Trident I (C4) on the right is most marked in this picture. The 'Aerospike' in the nose extends after launch and the flat plate creats an airflow equivalent to that of a long, tapering nosecone. This enables the missile to have a blunt nose, resulting in a shorter missile requiring a reduced diameter pressure hull (Lockheed)



Tennessee *(SSBN 734) was the first to carry Trident II (D5) missiles* (Giorgio Arra)

TUBES

Four 533 mm (21 in) Mk 68 bow tubes.

TORPEDOES

Hughes (Gould) Mk 48 Mod 3/Mod 5 (ADCAP)

The Mk 48 Mod 3 torpedo is fitted with a two-way wire link, which allows data from the weapon's homing and guidance system to be relayed to the submarine fire-control system, enabling the weapon to be guided more accurately from the submarine. The Mk 48 can be operated in wire-guided active or passive, acoustic and non-acoustic modes. The acoustic modes of operation allow active or passive target detection capabilities.

The Advanced Capability (ADCAP) version (Mk 48 Mod 5) has hardware changes which include a totally new nose unit; new electronics, signal processing and computers; and a modified fuel tank and afterbody sections, produced by Argo-Tech, which give increased fuel delivery rate and greater capacity for improved speed and endurance.

Some 2,700 Mk 48 torpedoes have been produced for the US Navy of which some 300 are new-build Mk 48 ADCAP weapons, although the US Navy hopes to acquire a total of 3,401 Mk 48 ADCAP torpedoes in due course.

Specifications
Length: 5.84 m (19.20 ft)
Diameter: 533 mm (21 in)
Weight: 1,587 kg (3,500 lb)
Max speed: 55 kts
Max range: 24.5 n miles (45.75 km)
Max depth: 914 m (3,000 ft)
Warhead: Mk 107—300 kg (660 lb)

Manufacturers/Contractors
Hughes Aircraft Company, Ground Systems Group (prime contractor).
Westinghouse Electric Corporation (second source).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

AN/WLR-8(V)5

AN/WLR-8 is a tactical radar warning system and the -(V)5 is designed specifically for 'Ohio' class SSBNs, covering frequencies from 50 MHz to 18 GHz. It provides comprehensive ESM (Electronic Support Measures) facilities and is compatible with NTDS (Navy Tactical Data System) and similar action information automation systems. Two digital computers are incorporated: a GTE PSP-300 for system control, automatic signal acquisition and analysis, and file processing; and a GTE PSP-200 microcomputer for hardware level control functions. Digital techniques are employed throughout the WLR-8 system, which is all solid state. Operational facilities provided include:

a. automatic measurement of signal direction-of-arrival
b. signal classification and recognition
c. sequential or simultaneous scanning over a wide frequency range
d. signal activity detection for threat warning
e. analysis of signal parameters such as frequency, PRF, modulation, pulsewidth, amplitude and scan rate
f. logging of signal parameters for display to operators and printout of hard copy to teletype or printer
g. extensive built-in test equipment
h. directed priority searches of specific frequency segments.

Direct reporting to onboard computers, such as NTDS, permits response times in the millisecond range with minimal operator involvement. A two-trace CRT is provided for display purposes, which can be supplemented by an optional five-trace panoramic display for presentation of signal activity data.

Manufacturer/Contractor
GTE Electronic Defense Systems Sector, Mountain View, California, USA.

AN/WLR-10

AN/WLR-10 is a radar-warning system, sharing a periscope antenna with the WLR-8 system.

ESCO ADC Mk 2 Mod 1

Eight launchers for ADC (Acoustic Device Countermeasure) Mk 2 Mod 1. ADC Mk 2 Mod 1 is an expendable, submarine-launched decoy designed to counter acoustic torpedoes. 8 cm in diameter, it hovers vertically at a preselected depth emitting an acoustic signal. The lower electronics section, in which the signals are generated and amplified, consists of ceramic transducers and impedance-matching networks for the acoustic transmitter. Above this section is a thermal battery which powers a pressure-controlled motor driving a small, shrouded propeller which keeps the decoy hovering. Originally manufactured by Emerson Electronics (now ESCO) it is now being manufactured by ESCO subsidiary, Hazeltine.

Manufacturer/Contractor
Hazeltine Corporation, Greenlawn, New York, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Command and Control System Mk 3 (CCS Mk 2)

CCS Mk 2 provides command and control, weapons control, TMA (target motion analysis) and OTH (over-the-horizon) targeting capabilities, and makes extensive use of commercial off-the-shelf (COTS) hardware design and software products.

Prime computer in the system is the Paramax AN/UYK-43 with a UYK-44 to process over-the-horizon targeting software, supplemented by a CP-2037/UYK parallel processor to speed up target track correlation. Software is written in both CMS2 and Ada.

There are four Mk 130 Common Display Systems (CDS) for close operator interaction with the system, of which two can be used for over-the-horizon targeting. The Mk 130 is based upon Silicon Graphics technology, and is capable of an operating speed of 8 Mips. It features a 48.26 cm (19 in) raster-scan main display with 1,280 × 1,024 pixels and is capable of showing video from any two sensors, graphic and alphanumeric overlays, as well as up to 16 'windows'.

The prime sensors in the Ohios' CCS Mk 2 is the IBM AN/BQQ-6 sonar suite which is similar to BQQ-5 but without an active element.

Manufacturer/Contractor
Raytheon Electronic Systems, Portsmouth, Rhode Island, USA.

WEAPONS CONTROL

Mk 98

The Mk 98 fire-control system is used to control the selection, targeting and launching of the Trident II (D5) SLBMs. All details are classified.

Mk 118

The Mk 118 torpedo fire-control system is similar to the Mk 117 installed in the US Navy's SSNs, but is less capable. It has only two Mk 81 WCCs (Weapon Control Consoles) and it is integrated into the submarine's command and control system. The weapon launch console in the torpedo room has two torpedo control panels and a Mk 96 weapons launch console which includes a digital-analogue data signal converter. The Mk 118, whose hardware weighs 1.46 tonnes, is normally associated with the IBM AN/BQQ-6 sonar system, which incorporates the passive elements of BQQ-5 and BQS-13.

NAVIGATION

Periscopes

One Kollmorgen Type 152; one Kollmorgen Type 82.

Manufacturer/Contractor
Kollmorgen Corp, Electro-Optical Division, Northampton, Massachussets, USA.

Navigation system

Each submarine has two Mk 2 Ship's Inertial Navigation Systems.

RADAR

Specifications
AN/BPS-15A
Role: Surface search/navigation/fire control
Frequency: I-band
Beam: 3 × 13°
Peak power: 35 kW
Antenna gain: 29 dB
Pulsewidth: 0.1/0.5 µs
Pulse repetition frequency: 1,500/750 pps
Scan rate: 9.5 rpm

Manufacturer/Contractor
Sperry Marine, Charlottesville, Virginia, USA.

SONAR

AN/BQQ-6

The 'Ohio' class is fitted with the IBM AN/BQQ-6 integrated sonar suite, which is essentially a passive-only version of the AN/BQQ-5 system used in the 'Los Angeles' class. Major elements are the Raytheon AN/BQS 13 bow-mounted, spherical hydrophone array and the Western Electric AN/BQR-15 passive towed array, with Rockwell BQQ-9 signal processor, the latter being particularly intended to detect targets astern of the SSBN. Other elements of the suite are the Ametek AN/BQS-15, an active/passive sonar for close contacts, particularly for use under ice, which is sited in the forward edge of the sail, and the Raytheon AN/BQR-19 mast-mounted, short-range, high-frequency, active sonar set, which is intended for use when surfacing.

Manufacturers/Contractors
Raytheon Company, Lexington, Massachusetts, USA.
Rockwell Corporation, Anaheim, California, USA.
Western Electric, Greenboro, North Carolina, USA.

PROPULSION

Specifications

System: Nuclear
Reactor: One General Electric S8G, natural circulation, pressurised water reactor (PWR)
Steam turbines: 2
Power output: 44.8 MW (60,000 hp)
Shafts: 1
Auxiliary propulsion: 1 Magnetek auxiliary prop motor
Power output: 242 kW (325 hp)

Manufacturers/Contractors

General Electric, Fairfield, Connecticut, USA
MagneTek Inc, Anaheim, California, USA

FURTHER INFORMATION

PROGRAMME

An 'Ohio' class SSBN with its 24 Trident II (D5) SLBMs is the most powerful single weapons platform ever to enter service and, together with the contemporary SSBNs of other navies, it demonstrates that submarine-based strategic missiles represent a combination of power, stealth and survivability unequalled by any air-borne or land-based system.

The original US submarine-launched ballistic missile (SLBM) was the Polaris, which made its first successful flight from an operational submarine in 1962. This was followed by the Poseidon (UGM-73) which began its operational deployments in 1971; 619 missiles were manufactured and, at its peak, Poseidon armed no less than 31 US Navy SSBNs. Meanwhile, Trident I (C4) (UGM-96A) was under development, with the aim of achieving greater range with a similar payload, and it was decided that there needed to be a new submarine to take full advantage of the new missile. It was also decided to increase the missile load from 16 to 24 SLBMs, an increase of 50 per cent. The first of the 'Ohio' class submarines was laid down on 10 April 1976, launched on 7 April 1979 and commissioned on 11 November 1981. After running the inevitable first of class trials *Ohio* (SSBN 726) conducted its first deterrent deployment from 1 October to 10 December 1982.

The original plan was to build 24 ships, but this has since been cut back to 18. The first eight of the class (*Ohio* (SSBN 726) to *Nevada* (SSBN 733), both inclusive) are equipped to fire Trident I (C4) missiles and the remaining 10, the Trident II (D5) missile.

DESIGN

The size of the Trident submarine is dictated primarily by the 24 vertical launch tubes for the Trident missiles, a 50 per cent increase over all previous SSBNs. Such a large ship also requires a large reactor plant to drive it. This has led to the largest submarine ever built in the West, although it is still considerably smaller than the Russian 'Typhoon' class SSBN. The nuclear reactor uses natural circulation, which was pioneered in the General Electric GE S5G reactor tested in *Narwhal* (SSN 671). The advantage of such a system is that it does away with the need for circulation pumps, which are a major source of noise in SSBNs or SSNs fitted with them. The nuclear core has a life of about nine years between refuellings.

DEPLOYMENT

Pacific Fleet units are based at Bangor, Washington, while those in the Atlantic Fleet are based at King's Bay, Georgia. The operational cycle of the 'Ohio' class is based on a 70-day patrol, followed by a return to base for precisely 25 days, where the necessary repairs are accomplished and the crews changed over before sailing on the next patrol. This schedule means that these ships will spend 66 per cent of their life, from commissioning to decommissioning, at sea, including shipyard overhauls. Such overhauls will be at nine year intervals. In the current less stringent strategic situation a modified alert status has been implemented. It was even suggested in 1992 that the patrol rate should be reduced so that single crews should be considered, or, alternatively, that the number of 'Ohio' class SSBNs should be reduced to 12. All these proposals were rejected.

MISSILES

Trident I: The UGM-96 Trident C4 missile was designed to improve the range capability of the Poseidon missile, thus providing the SSBN fleet with more sea room and hence greater survivability. Trident I (C4) entered service in 1979 and by 1987 was operational in eight 'Ohio' class ships (24 missile tubes) and 12 'Franklin' and 'Madison' class (16 tubes each) ships which had been converted to take the new missile. Six of the latter, former-Poseidon boats, carrying Trident I missiles were decommissioned in 1994 and the remaining six in 1996.

Trident II: The first D5 was launched from a land pad in January 1987, and the first sea launch, a failure, was in March 1989. The full test programme has been completed with a total of 48 firings recorded by 1993. The original size of the 'Ohio' class was expected to be 24 boats which, with 24 tubes per boat, would have resulted in a total requirement for 768 missiles of the D5 type. From 1991, however, the total number of boats was reduced to 18 which automatically reduced the missile requirement to 428, and a further rationalisation of boats and missiles will have to be made following the agreement to limit SLBMs by the START 1 and 2 agreements.

It is expected that the D5 missile will be downloaded to carry 4 RVs during the 1990s, but reports indicate that single warhead and even conventional HE warhead versions are being considered for future development. The D5 became operational with the US Navy in 1990 and will equip a total of ten 'Ohio' class SSBNs, when the last joins the fleet in 1998. The D5 production programme is currently building some 50 to 60 missiles per year, but it is not clear if production will continue to the full projected number of 428 missiles by 2000. By 1994 there had been 55 launches in US Navy trials.

The UGM-133A Trident D5 missile, together with the 'Ohio' class boats form part of a new capability for the US Navy, as they not only extend the range, payload and inventory of the missile force but they also introduce a hard target capability to the submarine-based missile. This accuracy is being achieved through sophisticated improvements to the ship navigation system and to the missile.

COMMUNICATIONS

These ships are fitted to receive Extremely Low Frequency (ELF) communications from two transmitter sites in Michigan and Wisconsin. This system enables SSBNs to receive signals while proceeding at greater depths and higher speeds than was possible with previous systems, although the data transfer rate is very low. Improvements are also being made to the communications systems to improve operational flexibility .

THE FUTURE

Many plans have been made for the future of the SSBN fleet in the light of the end of the Cold War, the reduced state of international tension (at least at the strategic level) and the resulting dramatic budgetary cuts. In 1996 the plan is to maintain a force of 14 'Ohio' class hulls, which means that four of the earlier submarines equipped to launch Trident I (C4) will have to be paid

UNITED STATES SLBMs FROM POLARIS TO TRIDENT

Missile		Polaris A1	Poseidon C3 (UGM-73A)	Trident I C4 (UGM-96A)	Trident II D5 (UGM-133)
Entered service		1960	1971	1979	1988
Dimensions	**Length**	8.53 m (27.98 ft)	10.36 m (34.00 ft)	10.36 m (34.00 ft)	13.96 m (45.8 ft)
	Diameter	137 cm (54 in)	188 cm (74 in)	188 cm (71 in)	189 cm (74.4 in)
Range		1,187 n miles (2,200 km)	2,483 n miles (4,600 km)	3,837 n miles (7,021 km)	4,000 n miles (7,400 km)
Launch weight		12,700 kg (28,000 lb)	29,500 kg (65,000 lb)	29,954 kg (66,035 lb)	58,068 km (128,000 lb)
Throw weight		499 kg (1,100 lb)	1,497 kg (3,300 lb)	1,361 kg (3,000 lb)	2,722 kg (6,000 lb)
Propulsion	**Stages**	2	2	3	3
	Fuel	Solid	Solid	Solid	Solid
Guidance		Inertial	Inertial	Inertial	Stellar-aided inertial
Warheads (Note 1)	**Number**	1	10	8	10
	Yield	600 kT	40 kT	100 kT	475 kT
	Type	Single	MIRV	MIRV	MIRV
CEP		0.97 n miles (1.8 km)	0.25 n miles (463 m)	0.24 n miles (450 m)	0.07 n miles (122 m)

Note:
1. Number of re-entry vehicles varied with range required and missile mission. Number shown is average

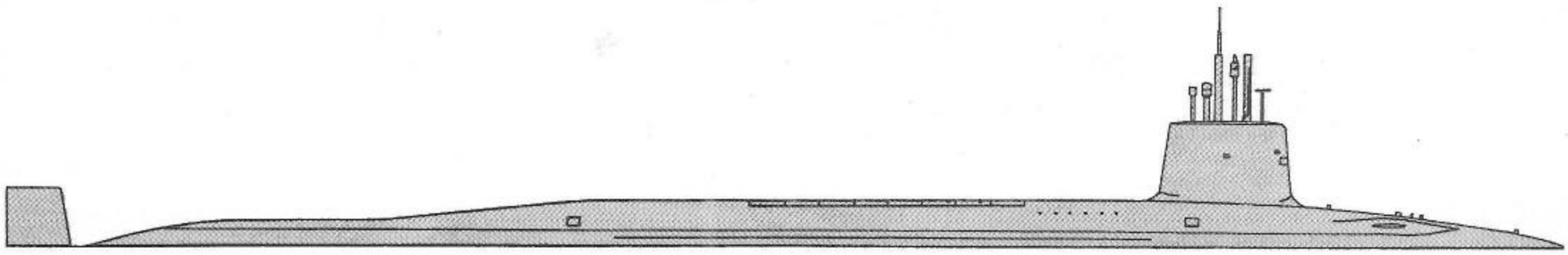
off, probably by late 1997, but they will then be converted to other roles. The US Navy would appear to have little need for additional SSNs, but the large size of the Ohios would seem to make them particularly appropriate for use as transports. The same plan includes a proposal to refit the four remaining Trident I submarines to launch Trident II missiles, thus ensuring a homogeneously armed fleet.

A wide variety of mid-course updating techniques and terminal guidance systems for the RVs are being considered to enhance their accuracy yet further. In October 1993 *Nebraska* (SSBN 739) fired a Trident missile to test the use of GPS hardware for fixing the location of the re-entry vehicles. This was part of a series of trials which could result in the development of a mid-course guidance package to produce true pinpoint accuracy. For nuclear warheads such accuracy, combined with an earth-penetrator would enable the missile to carry out attacks on underground, hardened, command and leadership centres. Alternatively, the accuracy could be used in combination with a conventional warhead for very precise attacks against targets such as semi-hardened bunkers and leadership buildings. Proposals were made in 1994 to develop a conventionally armed SLBM version of the Trident I (C4) missile, using a single penetrator warhead to attack command bunkers or underground facilities, although a recent US Government announcement indicated that such an option is not being pursued.

The WLY-1 acoustic intercept and countermeasures system is to be fitted in the submarines in the late 1990s. This is an automatic response system designed for defence against torpedo attack.

Alabama (SSBN 731) (US Navy)

VANGUARD



Vanguard (Ian Sturton)

GENERAL SPECIFICATIONS

Operator: UK
Type: Nuclear-powered, ballistic missile-armed submarine (SSBN)

Class: VANGUARD

Active: 1
Building: 3
Proposed: 0

Displacement, submerged: 15,900 t
Length: 149.9 m (491.8 ft)

Beam: 12.8 m (42 ft)
Draught: 12 m (39.4 ft)

Speed, submerged: 25 kts

Complement: 135 (14 officers) (2 crews)

SUBMARINES

VANGUARD (S 28)

Builder	Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Laid down	3 Sep 1986
Launched	4 Mar 1992
Commissioned	14 Aug 1993

VICTORIOUS (S 29)

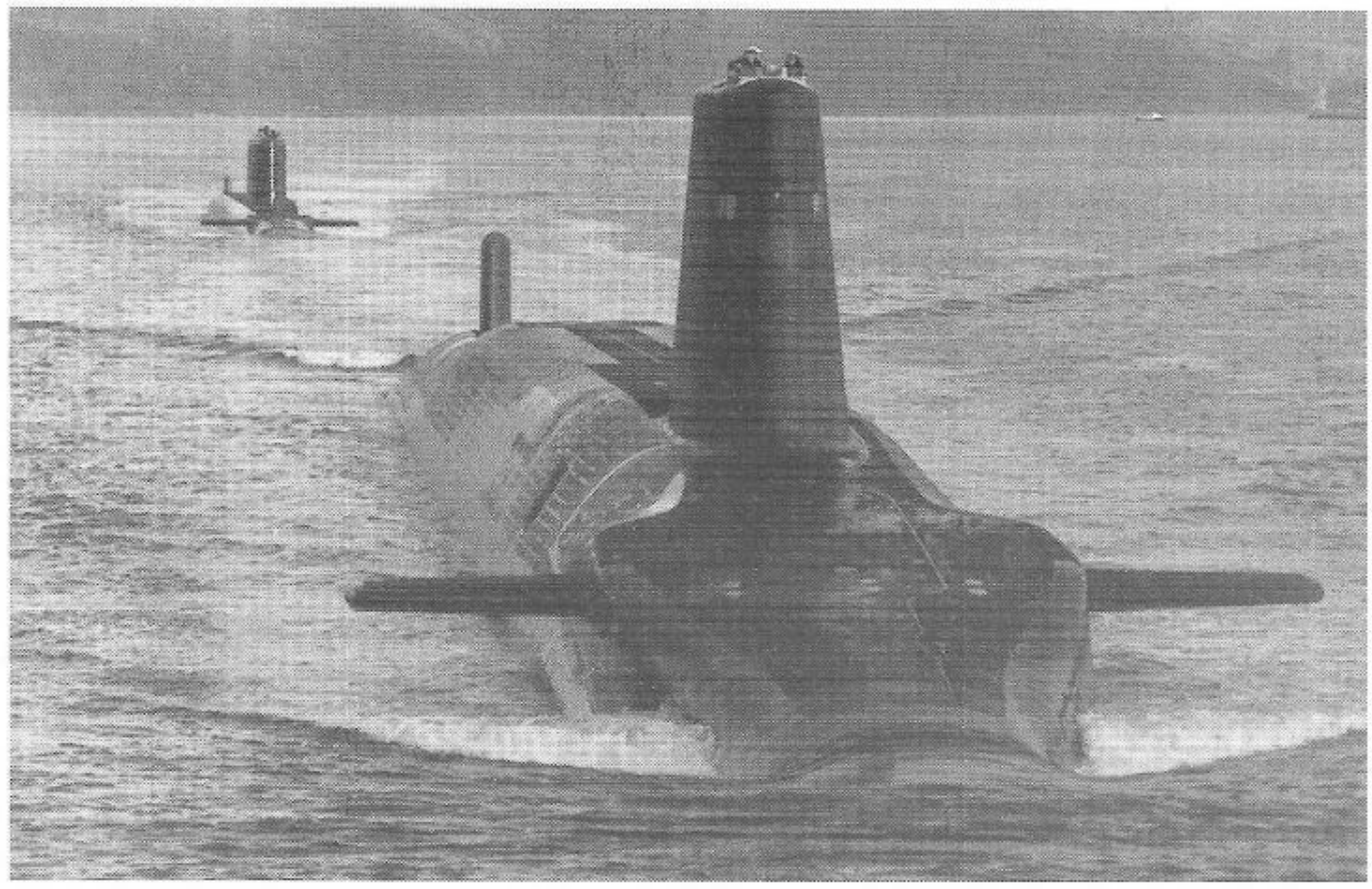
Builder	Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Laid down	3 Dec 1987
Launched	29 Sep 1993
Commissioned	7 Jan 1995

VIGILANT (S 30)

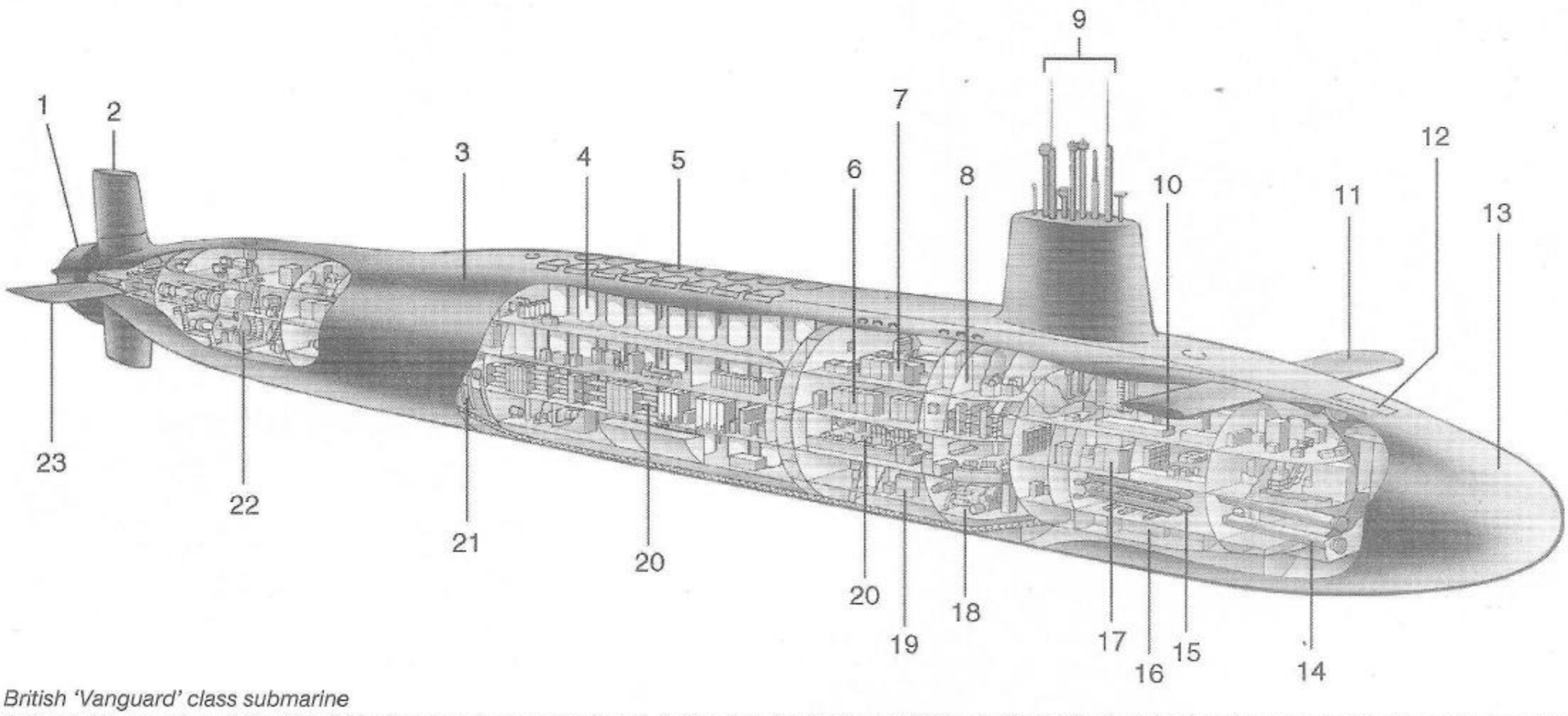
Builder	Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Laid down	16 Feb 1991
Launched	July 1995
Commissioned	Apr 1997

VENGEANCE (ex-Valiant) (S 31)

Builder	Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Laid down	1 Feb 1993
Launched	June 1997
Commissioned	Mar 1999



Vanguard *(S 28) leads a 'Resolution' class ballistic missile submarine out of a Scottish loch. Although both carry the same number of missiles (16) the new class is considerably larger* (HMS *Neptune*)



British 'Vanguard' class submarine
1 *Pump-jet propulsor* **2** *Rudder* **3** *Nuclear reactor compartment* **4** *16 tubes for Trident II (D5) missile* **5** *Missile tube hatch covers* **6** *Missile control centre* **7** *Navigation centre* **8** *Stores* **9** *Periscopes, mast-mounted sensors, snort tube* **10** *Communications centre* **11** *Forward hydroplane (non-retractable)* **12** *Torpedo access hatch* **13** *Bow-mounted hydrophone array* **14** *4–533 mm (21 in) torpedo tubes* **15** *Weapon stowage compartment* **16** *Auxiliary machinery space* **17** *Operations complex* **18** *Diesel generator room* **19** *Motor generator room* **20** *Accommodation* **21** *Auxiliary machinery space* **22** *Main machinery space* **23** *After hydroplanes* (UK MoD)

WEAPONS SYSTEMS

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBM)

UGM-133 Trident D5

Sixteen Trident II (D5) missiles equip the four 'Vanguard' class SSBNs. The D5 missile together with the accuracy of the warheads has, for the first time, given the British Navy's SSBN force a 'hard target kill' capability. The practical payload limit, depending upon the range required, is 12 MIRVs but, under British Government plans announced in November 1993, each submarine will carry a maximum of 96 warheads (of UK manufacture), with a 'total explosive power no greater than that carried in the 'Resolution' class'. In addition, it has since been announced that some of the missiles will carry a single 'sub-nuclear' warhead.

Specifications

Length: 13.42 m (44.03 ft)
Body diameter: 2.11 m (6.92 ft)
Launch weight: 59,090 kg (130,293 lb)
Guidance: Inertial with stellar reference update
Range: 6,500 n miles (12,000 km)
Propulsion: 3-stage solid propellant
Payload: max (START I) — 8 British warheads
Warheads: 8—100-120 kT
Accuracy — circular error probable (cep): 0.048 n miles (90 m)
Throw weight: 2,800 kg (6,172 lb)

Manufacturers/Contractors

Lockheed Missiles and Space Company (LMSC), Sunnyvale, California, USA (prime).
Lockheed Martin (second source).

TUBES

Four 533 mm (21 in) tubes in bow.

TORPEDOES

GEC-Marconi Spearfish

Spearfish is a dual-purpose torpedo, designed to counter fast, deep diving, quiet and strong-hulled submarines as well as surface targets, where the acoustic fuzing system detonates the warhead under the hull, creating a whipping effect to break the ship's back. Primary operation is in the passive mode, but with an active mode for use against very quiet targets, or in the final stages of attack, where the powerful transmitters have a long detection range and 'burn through' enemy countermeasures. Target detection capabilities are further enhanced by an array with many times the search volume of Tigerfish, with frequency-agile transducers which enable salvo firing to be carried out.

The torpedo normally operates autonomously, relaying data back to the submarine, but the command team can assume control at any time. The wire is dispensed from two reels, one in the torpedo, the other in the submarine launch tube, using a dispenser which allows discharge at high submarine speeds as well as giving the submarine complete freedom of manoeuvre after launch. Spearfish contains a number of homing and tactics computers to control the weapon, enabling it autonomously to select search detection and attack modes, to classify signal returns, to decide on appropriate tactics including re-attacks on the target if necessary, and to classify, track and overcome countermeasures and decoys.

Specifications

Length: 7 m (22.96 ft)
Diameter: 533 mm (21 in)
Weight: 1,850 kg (4,078 lb) (in air)
Speed: Approx 65 kts (max)
Range: Active/passive homing to 14 n miles (26 km) at 70 kts; attack speed 55 kts
Warhead: 300 kg (661 lb) blast and shaped (directed energy) PBX-104 warhead
Engine: Sundstrand 21TP01 gas turbine using Otto fuel

Manufacturer/Contractor

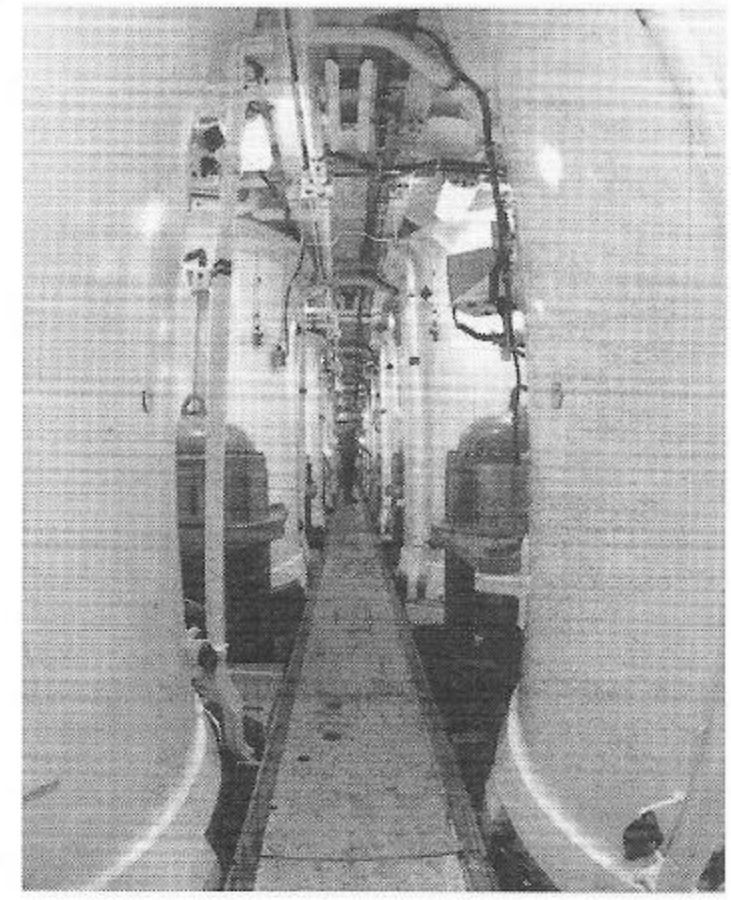
GEC-Marconi Underwater Weapons Systems Ltd.

GEC-Marconi Mk 24 Tigerfish

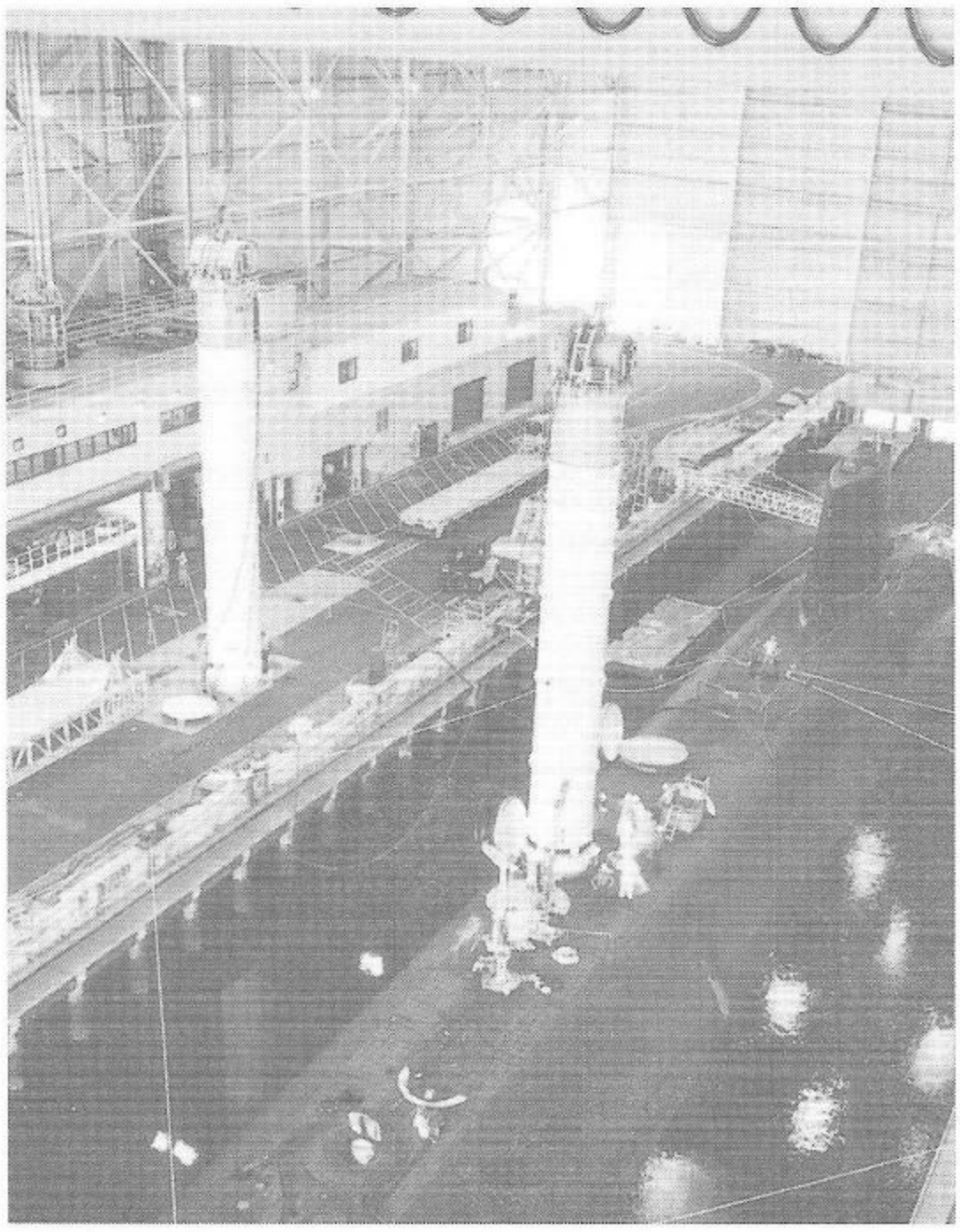
Tigerfish uses the passive mode whenever possible, with the interrogation rate being progressively increased as the torpedo nears the target to improve system accuracy. The onboard computer performs several functions during the attack, including interrogation control, sonar data computation, torpedo steering control and data transmission to the submarine to update its computer memory. The onboard computer is connected through the guidance wire to the submarine's torpedo fire-control computer. During the wire guidance phase the torpedo's computer responds to the demands of the submarine computer, with wire being dispensed from both torpedo and submarine to avoid any stress due to their relative motion. Wire guidance ceases at the point where the torpedo's automatic three-dimensional passive/active acoustic homing system can control the final run to the target and during this phase the torpedo computer interprets data from the homing system sensors to calculate and then command the appropriate course, subject to a priority overriding steer-off azimuth control from the submarine.

Specifications

Length: 6.46 m (21.19 ft)
Diameter: 533 mm (21 in)



The missile tubes aboard Vanguard (HMS *Neptune*)



A Trident II D5 missile in its capsule is lowered into its launch tube (UK MoD)

The torpedo room aboard Vanguard. *These are four 533 mm (21 in) tubes for a mix of Spearfish and Tigerfish torpedoes* (HMS *Neptune*)

Weight: 1,550 kg (3,417 lb) (in air)
Propulsion: Electrically driven contrarotating propellers
Speed: 24 kts (passive), 35 kts (active). (Some sources suggest a max speed of 50 kts)
Range: 7.5-22 n miles (13-39 km) (estimated)
Max operating depth: 610 m (2,000 ft) (estimated)

Warhead: Royal Ordnance 134 kg (295 lb) PBXN 105 warhead
Fuze: Dual-action impact (inertia-type) and proximity (magnetic)
Power: 2 Chloride silver-zinc oxide batteries driving a two-speed electric motor
Propellers: 2, contrarotating

Manufacturer/Contractor
GEC-Marconi Underwater Weapons Systems Ltd.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Racal Outfit UAP 3
UAP(3) is a variant of the UAP(1) system and is specifically designed for the 'Vanguard' class SSBNs. The system measures the parameters of received radar signals and compares them with a library of parameters. Signal identity, bearing and threat category are displayed in tabular format. Raw data on bearing and frequency are given on a display which can be overlaid with symbols and data derived from the signal analysis processor. Specific intercepts can be analysed in greater depth using a manual pulse analyser. UAP(3) benefits from the Racal Sadie signal analysis processor which permits data rates of up to 500,000 pps to be handled with no degradation. Additionally, a fully representative onboard trainer is integrated within the operator's console.

Manufacturer/Contractor
Racal Radar Defence Systems Ltd, Chessington.

DECOYS

Two SSE Mk 10 launchers.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS AND DATALINKS

Submarine Command System — 'Vanguard' class (SMCS-V)
The Submarine Command System — 'Vanguard' class (SMCS-V) is based upon a distributed nodal architecture involving Racal-made software-driven MultiFunction Consoles (MFC) linked by a fibre optic local area network (LAN). This LAN uses the IEE 802.5 standard J & S Marine Combat Systems Highway (CSH), which has a 3 MHz bandwidth of which 2 MHz is available. Access between the combat system and the other weapons and sensors is via a gateway, since it is not necessary for all the consoles to interface directly with the CSH. These gateways, which are duplicated to provide redundancy, perform the functions of interface conversion, preprocessing and data-filtering before it is passed to the command system. The MFCs are produced by Racal Radar Defence Systems and each has a Multibus II 32-bit databus, provided by Dowty Maritime Systems' Gresham Division. There are databus, input/output, general purpose and node service cards, two display generator cards and a 60 Mbyte hard disk drive. The Dowty applications processors are based upon Intel 80286 32-bit microprocessors. In consoles requiring mathematical facilities for tasks such as TMA, the processor is supplemented by Inmos T800 high-speed (10 Mips) transputer arrays. To enhance performance, as many operations as possible take place in parallel, which also increases redundancy and reduces bottlenecks. The software architecture uses the Successor core system infrastructure software including the Ada-language run-time manager. The application software is added and the distributed database management systems ensure the data is handled quickly and reliably. The majority of the software has been provided by Sema Group Systems' Scientific Division. SMCS consists of four full MFCs and three similar, but less capable, display systems: a main tactical display and two remote terminals, of which one is in the control room and the other in the sonar compartment. The MMI of the water-cooled MFC includes touch sensitive panels, two plasma displays, two fire-control buttons and a graphics tablet. In addition to the MFCs, there are two common services nodes, both based upon Intel 80386 microprocessors, with six cards, a fixed number of Inmos T800 transputers and a 180 Mbyte bulk store. There are also two input/output nodes. An SMCS system will have between 150 and 200 32-bit processors in the system and will require 1 million lines of Ada language software code.

Manufacturer/Contractor
BAe-SEMA Combat Systems Division, New Malden, UK.

RADAR

Type 1007 navigation radar

Specifications
Role: navigation
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 31 dB
Pulsewidth: 0.08/0.35/0.8 µs
Pulse repetition frequency: 1,600/800/400 pps
Scan rate: 26 rpm

Manufacturer/Contractor
Kelvin Hughes, Ilford, Essex, UK.

SONARS

Marconi/Plessey Type 2054 composite multifrequency sonar suite includes Marconi/Ferranti Type 2046 towed array, Type 2043 hull-mounted active/passive search and Type 2082 passive intercept and ranging.

Type 2054 passive/active intercept and towed array sonar suite
Sonar 2054 consists of a suite incorporating passive, active, intercept and towed array sonars and is designed specifically for the 'Vanguard' class SSBNs. GEC-Marconi Naval Systems, Sonar Systems Division, as the prime contractor and system design authority, will supply the bow-mounted hydrophone array together with the necessary beam-forming and signal processing equipment (both narrowband and broadband), the intercept sonar equipment and the towed array. Major subcontractors are: Ferranti Computers for the consoles, data processing and displays, and Northern Telecom for the handling system for the towed array. The signal processing in the Type 2054 is almost entirely digital, the arrays being sampled by the preprocessor and immediately digitised before being passed to the beamformer. Signals are then stabilised for both ship's position and geographical location before passing down for further processing in FM, CW and passive modes. These provide bearing and range, target motion and torpedo detection capabilities. Subsequently the control and monitoring processing adds the ship's data to the detector signals and allows the operator to select particular modes of operation. This part of the system consists of two cabinets, one for target classification and the other for data display handling, which are interlinked using a Eurobus system and connected to the outside world by a MIL-STD-1553B standard data highway. The total system consists of 18 cabinets and six consoles (two broadband, two narrowband, one active and one intercept).

Manufacturers/Contractors
GEC-Marconi Naval Systems, Sonar Systems Division, Templecombe, UK (prime).
Ferranti-Thomson Sonar Systems UK Ltd, Stockport.
Northern Telecom Defence Systems, Newport, Gwent, Wales.

NAVIGATION

Navigation system
Ship's Inertial Navigations System (SINS) Mk 2.

Manufacturer/Contractor
Rockwell Corp, Anaheim, California, USA.

Periscopes
Search persicope: Pilkington Optronics CK 51.
Attack periscope: Pilkington Optronics CH 91.

Manufacturer/Contractor
Pilkington Optronics, St Asaph, Clwyd, UK.

PROPULSION

Specifications
System: Nuclear
Reactor: 1 Rolls-Royce PWR-2 (pressurised water reactor)
Turbines: 2 GEC-Alsthom steam turbines

Power output: 20.5 MW (27,500 hp)
Shafts: 1
Propulsor: 1 pump-jet propulsor
Auxiliary power: 1 auxiliary retractable propulsion motor; 2 WH Allen turbo generators; 6 MW; 2 Paxman diesel alternators; 2 MW (2,700 hp)

FURTHER INFORMATION

PROGRAMME

The British Government announced its decision to purchase the US Trident I (C4) weapon system on 15 July 1980. This was, however, changed on 11 March 1982 when it was announced that the government had decided to procure the improved Trident II weapon system, with the D5 missile, instead. These missiles would be deployed aboard a force of four submarines in the mid-1990s. The original programme anticipated ordering one per year over a period of three years, but, in the event, the building programme has been very protracted, with *Vanguard* being ordered on 30 April 1986; *Victorious* on 6 October 1987; *Vigilant* on 13 November 1990 and, after a long pause, *Vengeance* on 7 July 1992.

Victorious *(S 29) the second of the British 'Vanguard' class* (VSEL)

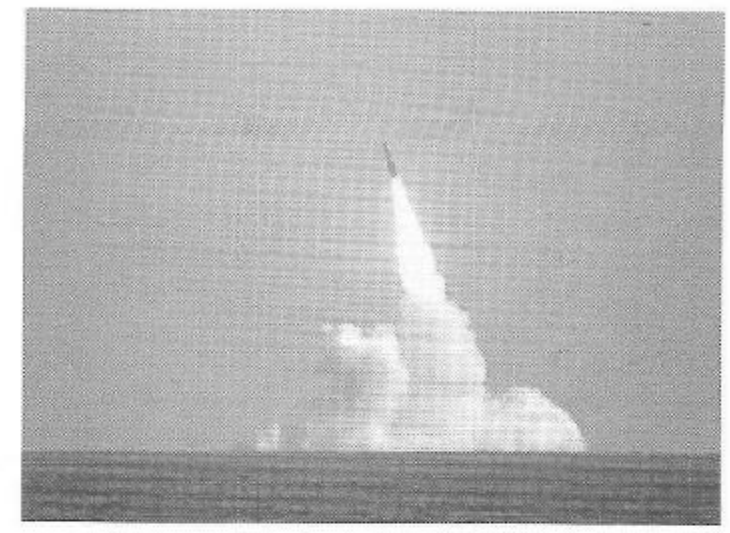
MISSILES

Each submarine has 16 missile tubes and each D5 missile is technically capable of carrying 12 warheads, thus giving a theoretical maximum of 192 warheads. The UK, however, has voluntarily limited this, first, to 128 warheads (that is, eight per missile) and later to 96 (that is, six per missile), although the option remains available to increase the load again at some time in the future, should the threat once again merit a greater capability. It should, however, be noted that there is a trade-off between payload and range, so that, assuming that the British re-entry vehicles are no heavier than their US counterparts, a consequence of reducing the number of RVs will be that the British missiles will fly farther, thus enabling British SSBNs to hit targets further away from the same patrol areas or to hit the same targets from a greater range.

A further decision has been made to utilise an unspecified number of D5 missiles in each SSBN to carry single warheads in a 'substrategic' role to replace the aircraft-delivered WE 177 nuclear weapon, which will be withdrawn from the inventory in the late 1990s. According to government announcements the overall limit would remain at 96, thus one possible loading in such circumstances would be 11 missiles with eight warheads, plus five missiles with a single warhead.

The D5 missiles have been purchased from the USA, but the warheads are British in design and construction, and their targeting is thus under wholly British control. The UK has, however, placed a maintenance contract for the missiles and their motors with the USA, as a result of which the missiles will be returned to the USA at regular intervals for servicing.

The UK Government has said that it has no plans to deploy conventional warheads on Trident, but the US



First launch of Trident II (D5) from the British SSBN, Vanguard (UK MoD)

Vanguard *conducting trials with a US Navy DSRV (Deep Sea Rescue Vehicle) mounted aft. The white lines are to assist the DSRV pilot in the docking manoeuvres* (HMS *Neptune*)

Navy fired a D5 missile in October 1993 to test the feasibility of increasing accuracy by mounting GPS navigational hardware in the missile. One possible application for such accuracy would be in a conventional kinetic energy weapon and presumably the possibility exists for the UK to change its mind in the future should the strategic/substrategic need arise.

DESIGN

This design is the largest submarine built outside Russia and the USA and by far the largest ever built in the UK. It is of conventional Western SSBN layout, with the missile section abaft the sail, although it has only 16 launch tubes as opposed to the US Navy's 'Ohio' class which has 24. British design practice is evident in the overall profile of the hull and in siting the forward hydroplanes in the bows and not on the sail, although, most unusually, the planes are permanently extended and not retractable. The sail is unusual in that it is tapered, although it follows modern practice by being faired into the hull. The entire outer surface of the submarine is covered with conformal, anechoic, noise-reduction coatings.

PROPULSOR

The 'Vanguard' class SSBNs are fitted with a British-designed shrouded propulsor. This device consists of an aerodynamically profiled rotor and stator housed inside a duct, which controls the water flow through the unit. Such a device provides considerable benefits, including much improved acoustic performance, lower shaft speed and greater protection against general marine debris and ice, although the design is more complex and the unit is heavier than a conventional propeller.

OPERATIONAL

Vanguard started sea trials in October 1992, with the first UK missile firing on 26 May 1994 and the first operational patrol early in 1995. Second of class *Victorious* started sea trials in August 1994. Two crews have been allocated to each submarine.

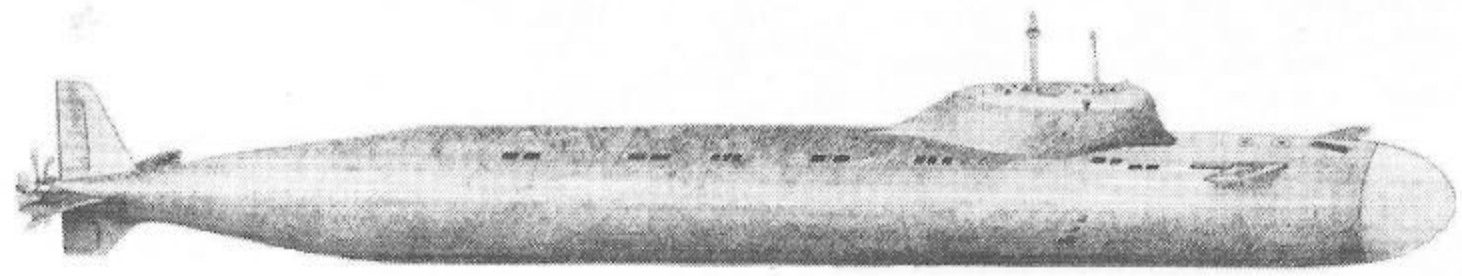
REFITS

Refit and recore interval is anticipated at eight to nine years, considerably less frequently than with the 'Resolution' class. On that basis a possible life-cycle for these ships might be:

Name	In service	Refit 1	Refit 2	Paid off
Vanguard	1993	2001-2003	2011-2013	2021
Victorious	1995	2003-2005	2013-2015	2023
Vigilant	1997	2005-2007	2015-2017	2025
Vengeance	1999	2007-2009	2017-2019	2027

ATTACK SUBMARINES NUCLEAR POWERED (SSN)

INTRODUCTION



A US Navy artist's impression of the new Russian SSN, Severodvinsk. *Despite all its other problems Russia has maintained its SSN force which remains effective and is improving technically* (US Navy)

The principle characteristics of modern submarines are firepower, mobility, stealth and endurance, and these qualities are possessed in greatest measure by nuclear-propelled attack submarines (SSNs). They are excellent anti-submarine platforms and possess a first-class anti-ship capability as well. Over recent years, however, they have also gained a land-attack capability using missiles such as Tomahawk, which gives them significant power projection potential. They also have several clandestine roles, including gathering intelligence of various kinds, and inserting and recovering special forces. They can also lay minefields and can serve as electronic warfare platforms.

Such a wealth of capabilities makes the SSN a particularly valuable naval system and it is noteworthy that in the recent arms reductions those navies already possessing SSNs have reduced many other prized systems rather than touch their SSN fleets. Indeed, several navies are now seeking to develop SSNs of their own: India and Brazil in the foreseeable future, and others, perhaps, in the longer term.

For several decades there has been a separate category of cruise missile-firing submarine, designated SSGN or SSG according to its means of propulsion. This type was particularly prevalent in the (then) Soviet Navy, where it was principally designed to engage NATO battle groups at long ranges using over-the-horizon targeting systems. Today, however, almost all attack submarines routinely carry missiles such as Tomahawk, Harpoon, Exocet and SS-N-21, which are launched from conventional torpedo tubes or vertical launch tubes. There does not appear to be any merit in allotting such submarines to a separate category all their own and they are, therefore, simply listed in with other SSNs in this section of *Jane's Major Warships*.

The existing SSN operators

The five existing SSN operators all have new classes of SSN either in production or in the last phase of design. What is clear, however, is that the pace of construction has slowed considerably and the numbers to be built have diminished greatly.

United States of America

The final 'Los Angeles' class hull was completed in 1996 and it would not be out of place to pay tribute to a design which has resulted in 59 submarines built over two decades in one of the most expensive defence programmes ever undertaken. The impact of such a programme should not, however, be reckoned in absolute cost, but in cost-effectiveness and there is no doubt that throughout the latter part of the Cold War the 'Los Angeles' class played a vital role in its essentially hidden battlefield.

In the late 1990s there is, however, a quite different defence regime, in which a multifaceted threat is combined with defence budgets bordering on the parsimonious. Thus, the commissioning of the last of the 'Los Angeles' class, USS *Cheyenne* (SSN 773), at the Newport News yard in August 1996 will be followed by the commissioning of the final 'Ohio' class SSBN, USS *Louisiana* (SSBN 743), at General Dynamics (Electric Boat Division) at Groton in August 1997. This, coupled with the drastic cutback in fleet size makes it highly probable that one of the two nuclear submarine building yards will be forced to turn to other business.

The only programmes in prospect are the 'Seawolf' class, currently under construction, which will not exceed three hulls, and the New Attack Submarine (NSSN), which is intended to possess a capability of about 75 per cent that of Seawolf, with a submerged displacement of about 7,000 tonnes and a speed of 28 knots. On the other hand, some radical innovations are being considered, including a modular concept in which a common propulsion section would be mated to sections containing different payloads, such as cruise missiles, or ballistic missiles, or even a transport module capable of accommodating up to 200 special operations troops. The first of class is scheduled for funding in FY98 with advance procurement funding starting in FY96.

In parallel with these hull programmes, there are numerous other developments in progress, including towed arrays with greatly enhanced detection capability and special hull treatments to curtail yet further the performance of hostile sensors, and improved offboard sensors and decoys are also being developed. In addition, the Mk 48 advanced capability (ADCAP) torpedo is coming into service, and improvements are planned for Tomahawk missiles.

In another area, research work is being done with the aim of producing tube-launched remote-controlled vehicles for a range of tasks including surveillance, communications and mine warfare.

Russia

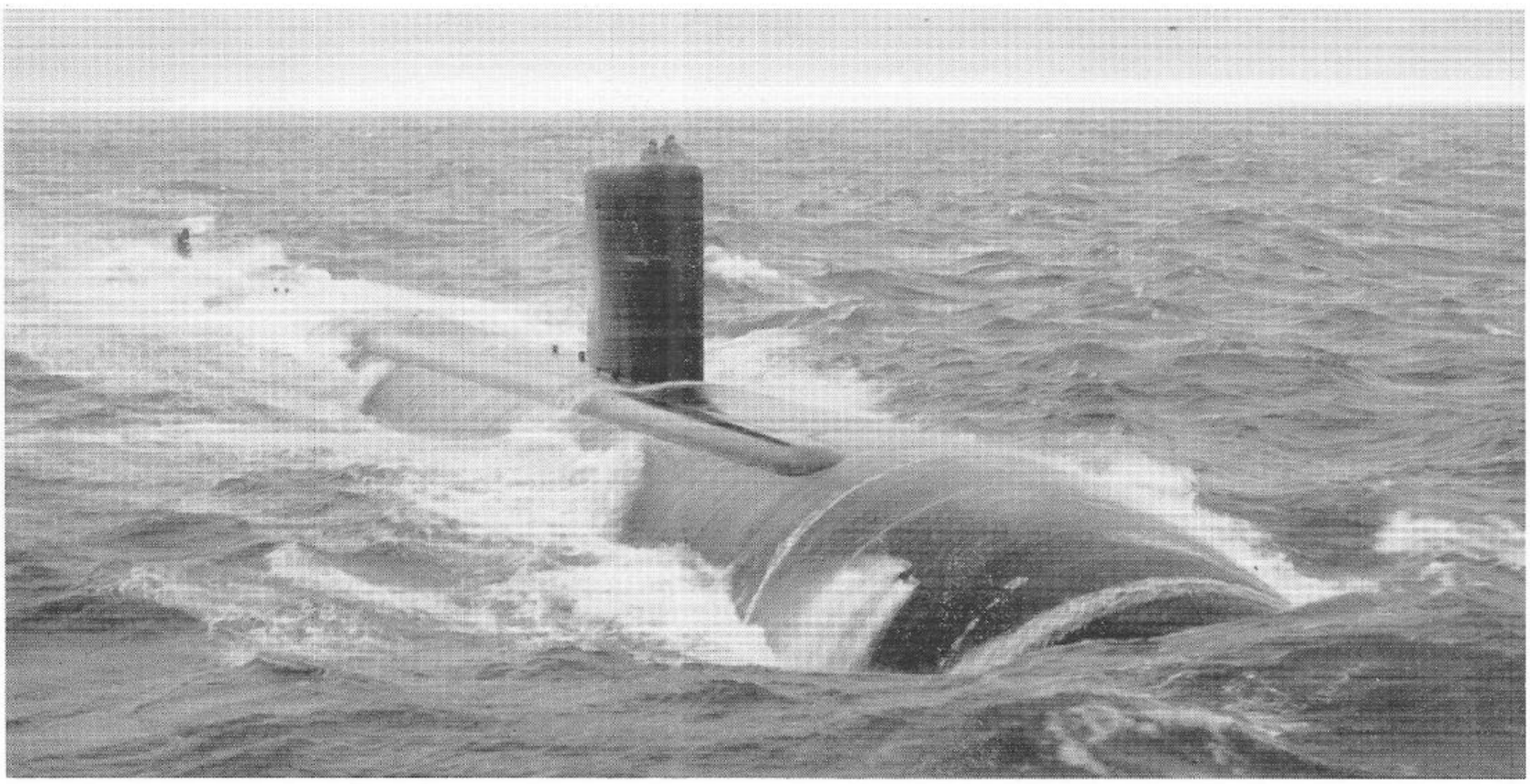
Despite cutbacks in many other areas, Russia has continued with the production of the 'Severodvinsk' class SSN. The first of class was launched in 1995 and reports indicate that at least seven are planned. Like other shipyards, however, the submarine yards have been disrupted by funding problems.

One of the most significant Russian advances is in weaponry where evidence is now accumulating that the navy possesses an extremely fast, conventionally launched torpedo. An artist's impression shown at recent international exhibitions has been confirmed by an independent, non-Russian authority as 'remarkably accurate, although several features have been deliberately deleted'. The drawing shows a rocket-powered missile travelling at some 100 m/s, such a speed being achieved by diverting part of the efflux from the tail-mounted rocket motor to the missile's nose where the projectile's momentum causes the gas to flow over the body of the projectile, thus creating the necessary vapour envelope. The shape of the hole also ensures that the apex of the vapour envelope assumes the optimum hydrodynamic shape for water penetration.

Inevitably, a rocket motor will generate considerable noise, preventing the use of an onboard sonar guidance system, and also making the projectile easily detectable by the target. In view of its speed, however, that would seem to be of little significance.

In a future conflict it is probable that submarines will get into a 'dogfight', circling each other in an attempt to achieve a firing solution, while seeking to prevent their opponent from doing the same. Slow-moving, conventional torpedoes would take too long to reach their targets but several *Shkvals* at short range would leave the enemy with insufficient time to take evasive action. This seems to fit in with a Russian designer's description of the weapon as having '...the lightning stab of a dagger'.

A second possibility is that *Shkval* would be used to compel a hostile submarine detected at a greater range to take violent evasive action. The noise created by such a sudden, evasive manoeuvre would confirm the location of the hostile boat, and, also, if that submarine had launched one or more wire-guided torpedoes, the wires between it and the torpedoes could be broken, negating the attack.



The US Navy's SSN-688/688I programme has been one of the most successful defence programmes ever undertaken (General Dynamics Electric Boat Division)

United Kingdom
The British Government has now placed an order for Batch 2 'Trafalgar' class SSNs (B2TC) although, despite the name, there is such a long gap since the last of the initial batch of Trafalgars was completed that this is essentially a new class.

British Submarine Pumpjet Propulsors

The British Navy has operated submarines fitted with pumpjets for the past 25 years, these devices having been fitted in all SSNs from the 'Swiftsure' class onwards, as well as all SSBNs, although not in the 'Upholder' class SSKs. The pumpjet can be compared to the turbofans used in jet aircraft propulsion, being, in effect, an underwater turbine consisting of a rotor, stator and a duct. The rotor and stator are discs of aerofoil section, the former rotating and the latter fixed, with both being surrounded by a duct which controls the water flow through the unit and gives it its distinctive profile.

There are two possible duct profiles, as shown in Figure A. The 'accelerating duct' on the left improves the propulsive efficiency of the device, but at the expense of cavitation or noise performance. On the other hand, the 'decelerating duct', (right) slows the flow, minimising cavitation performance, albeit with some efficiency penalties.

There are also two pumpjet configurations, as shown in Figure B, depending on the relative positions of the rotor and stator. The 'pre-swirl' type has its stator ahead of the rotor and provides superior control of the wake, but does not have the cavitation performance of the post-swirl unit. The other type, the 'post-swirl,' has the rotor ahead of the stator and has potentially better cavitation performance, although its construction — particularly the duct supports — is complicated. One advantage that both types have over an open-bladed propeller is that the duct gives the rotor protection from general maritime debris and against ice damage when operating in polar regions.

Pumpjets are considerably smaller in diameter than the equivalent open propeller, because the duct allows the blades to be loaded to their tips with no fall-off in thrust. Moreover, because the pumpjet design incorporates a duct to confine the operating environment of the rotor and stator there is greater scope for the designer to optimise the propulsor for low noise and/or efficiency. There are, however, some penalties, including higher costs associated with a more complicated design and increased weight at the after end.

The British Navy has operated submarines fitted with pumpjets for the past 25 years, during which time both pre-swirl and post-swirl types have been fitted.

Figure A

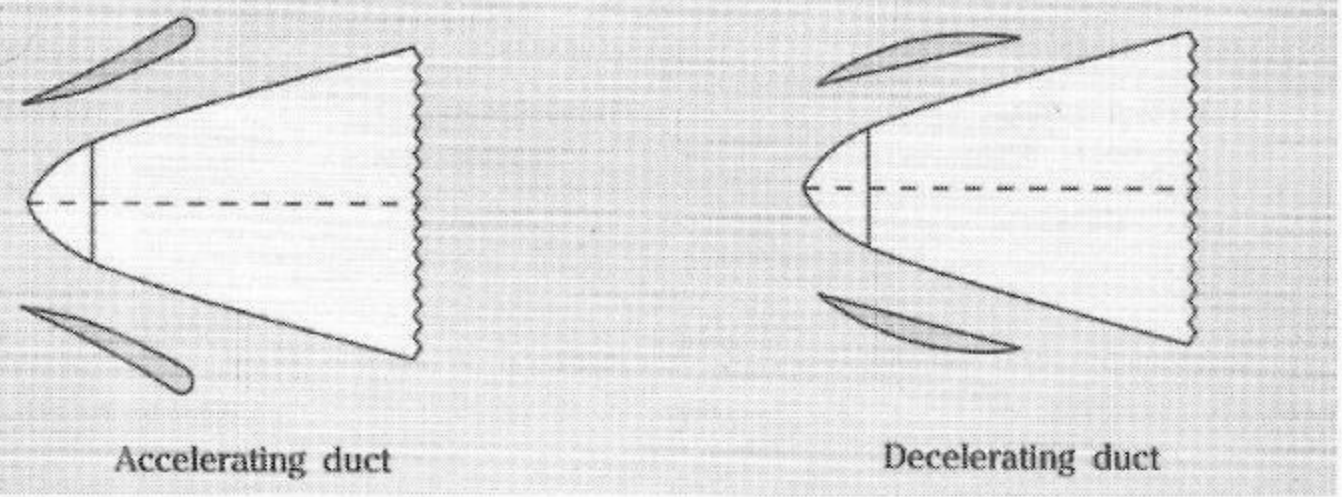
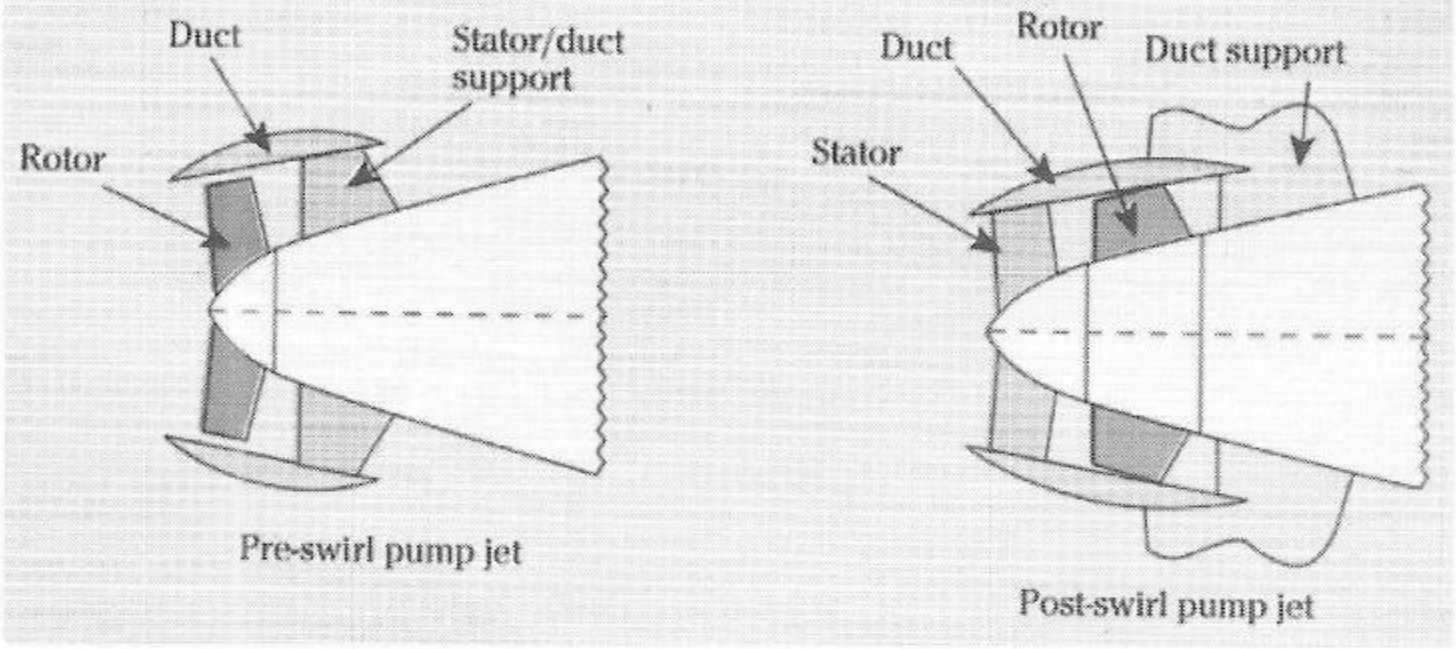


Figure B



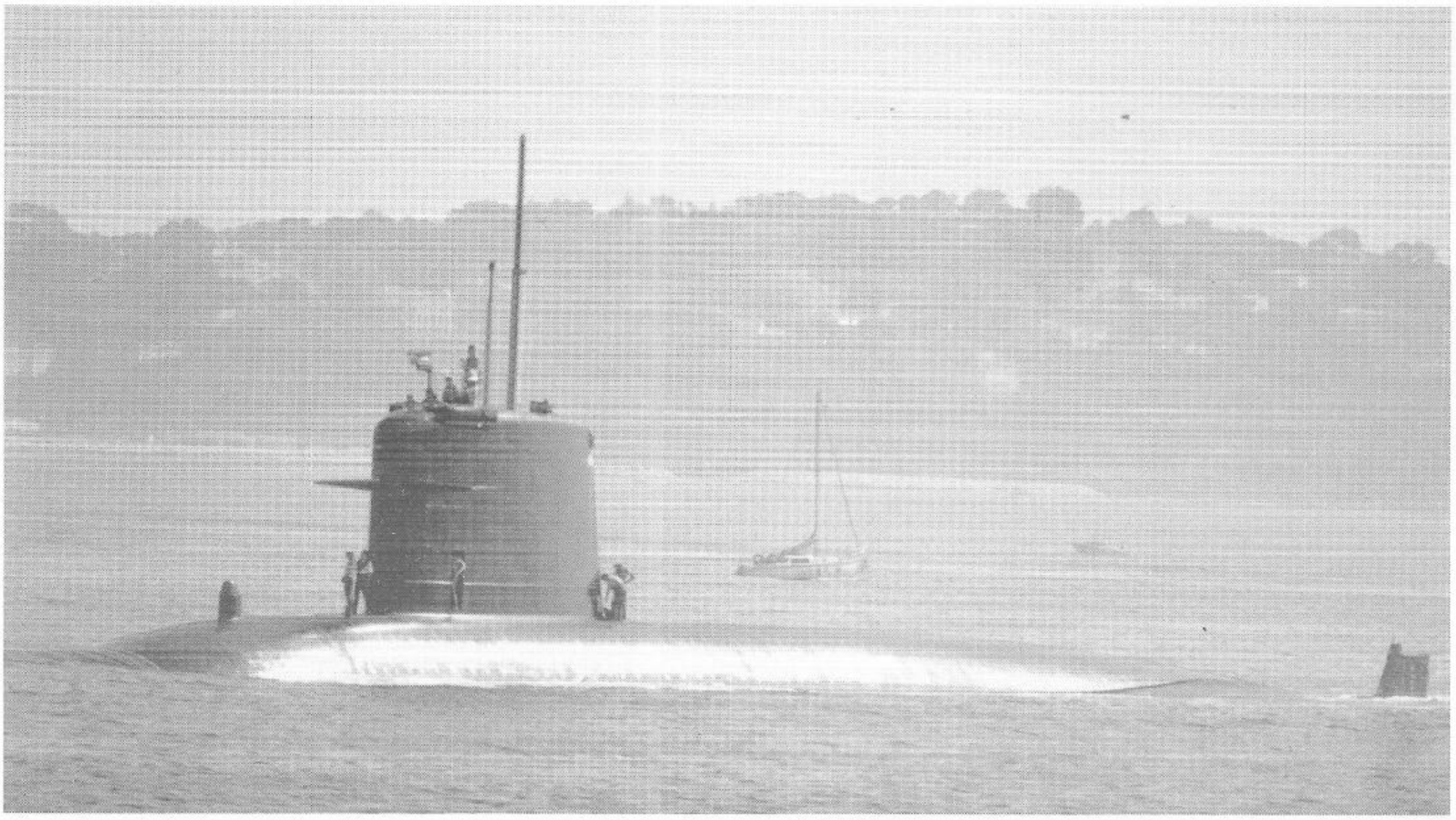
France
A new generation of SSNs has been funded under the 1995-2000 budget. The submarine will have a submerged displacement of about 6,000 tonnes and its armament will include a vertical launch SSM system. It is planned that the first of class will be laid down in 1998 and will enter service in 2007.

China
A new SSN design is being worked on in conjunction with experts from the Rubin Design Bureau of St Petersburg, Russia. Prefabrication work started at Huludao shipyard in late 1994, and the first launch is expected in 1998 with completion in 2001. Russian technical expertise is reported to be involved.

New SSN operators

Despite the costs of developing an SSN capability two further navies are approaching the final stages of design, with the Indian programme probably a few years ahead of that in Brazil. Apart from these two, however, no other navy is known to have plans for nuclear propulsion - at least for the moment.

Brazil
There is a long-standing plan for the construction of a Brazilian-designed submarine, powered by a Brazilian-designed and developed nuclear propulsion plant. These plans are proceeding, with a prototype nuclear reactor, the IPEN/MB-1, being built at Aramar, Ipero,



French SSN, Rubis, *ships quietly out to sea, one of a force of six attack submarines which will be maintained despite cutbacks elsewhere* (Jane's/H M Steele)

São Paulo. A uranium enrichment plant was inaugurated at Ipero in April 1988 and it is estimated that the prototype SSN, designated S-NAC-2, will have a submerged displacement of some 2,800 tonnes and will be powered by a 50 MW power plant giving it a submerged speed of 25 knots, which will make it slightly larger, and marginally faster than the French 'Rubis' class SSNs.

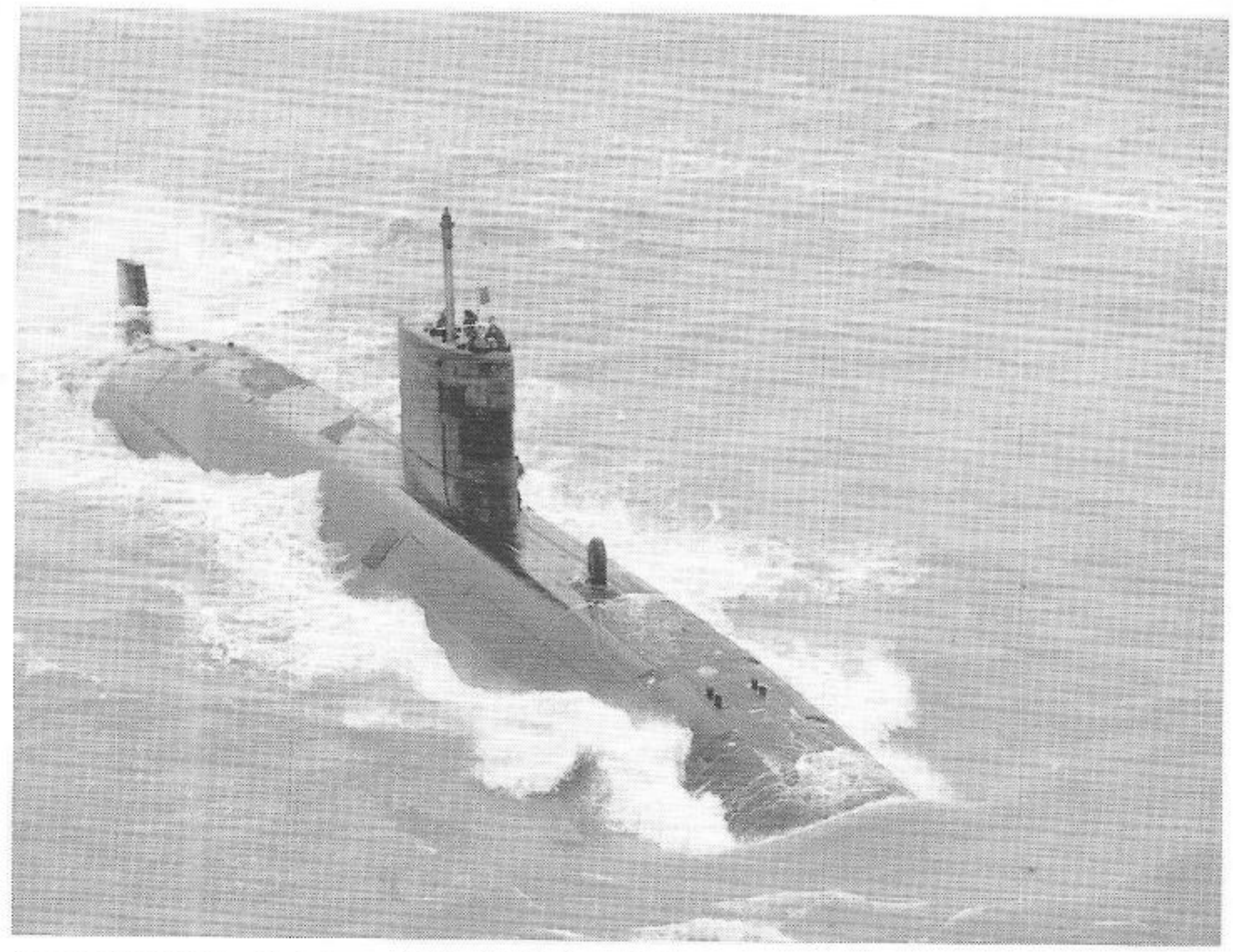
Submarine nuclear reactors must, however, be capable of changing power both dramatically and often, for which it is necessary that the fuel has been very highly enriched. It is problems in just this area of adequate enrichment of the fuel which are reported to have caused Brazil to postpone its plans for SSN construction well into the next century.

India

India has a programme for an 'advanced technology vessel' (ATV) (that is, a nuclear-powered submarine) to meet its long-held operational requirement to operate SSNs. The project team is headed by a vice-admiral, indicating a very high level of commitment, and has facilities in Delhi, Hyderabad, Vishakapatnam and Kalpakkam. It is also well funded and has priority over even the new aircraft carrier.

A 'Charlie II' class SSGN was leased from Russia in 1988 and operated as INS *Chakra* until 1991, when it was returned. It is believed that the Russians allowed Indian officials to 'stand by' the submarine during its construction and also supplied detailed hull drawings, neither of which is banned by existing international treaties, but did not supply details of the propulsion plant, which is.

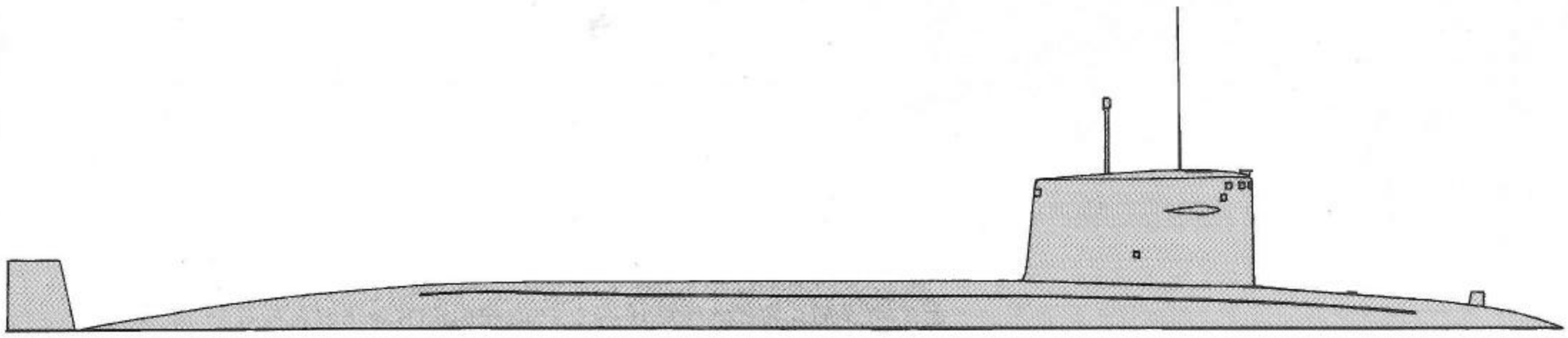
It was thought for some time that the ATV design would be based on that of the Charlie-II, but latest reports are that the Rubin Design Bureau of St Petersburg, Russia is involved in the project. In such a case, it is likely that the hull would be of a more advanced design — the Charlie IIs entered service with the Soviet Navy in 1973 — in which case the design might be similar to that of the 'Severodvinsk' class SSNs, the first of which was recently launched. The nuclear plant and its containment vessel will, however, be designed entirely in India and it is believed that the prototype is already running ashore.



The British SSN fleet is being maintained with its main front-line type being the Batch I 'Trafalgar' class, such as Triumph *(S 93) seen here. Orders for Batch II Trafalgars have at last been placed* (VSEL)

Construction of the first of class ATV is likely to start in 1997 with an intended in-service date of 2004. Reports of the possible size vary from 6,000 tonnes down to 2,600 tonnes, and the boat may be armed with either Russian or Indian cruise missiles. In the latter case, the missile would be the Sagrika, which is being developed by the Indian DRDO. It is reported to be powered by a turbojet and to have a range of some 300 km. The missile will be tube-launched and may use UAV updates during flight.

HAN



Han (Ian Sturton)

GENERAL SPECIFICATIONS

Country: People's Republic of China

Class: HAN

Built: 5
Active: 5
Building: 0

Displacement:
surfaced: 4,500 t
submerged: 5,550 t

Dimensions
Length:
401-402: 98 m (321.5 ft)
403-405: 106 m (347.8 ft)
Beam: 10 m (32.8 ft)
Draught: 7.4 m (24.2 ft)

Speed:
surfaced: 12 kts
submerged: 25 kts

Complement: 75

SUBMARINES

401
402
403
404
405

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Ying Ji (Eagle Strike)

There are persistent reports that the reason for the lengthening of submarines 403 to 405 is to accommodate an anti-ship missile launch-bin abaft the fin for C-801 or C-802 missiles, although there has been no visual confirmation of this to date. It is important to note that, if this is the case, target acquisition and missile launch must take place on the surface. Over-the-horizon target acquisition is reported to be achieved using an Elbit Timnex 4CH(V)2, which covers the 2-8 and 8-18 GHz bands with a choice of eight monopulse DF ports for each band. It is claimed to have a bearing accuracy of 1.5° and an emitter library of 500 modes.

The YJ-1 (C-801) is rocket-propelled with a rocket booster, and on launch it climbs to about 50 m (16 ft) then descends to 20 to 30 m (65.6 to 98.4 ft) until the radar seeker has acquired the target. It then descends to 5 to 7 m (16.4 to 23 ft) using the nose-mounted, monopulse (probably J-band), radar seeker for the terminal approach phase. The YJ-2 (C-802) is generally similar to the YJ-1 but is powered by a turbojet with paraffin-based fuel to give a considerable increase in range. To accommodate the new power plant the fuselage is extended forward of the wing leading-edge with the fuel tank behind the instrument compartment, while an air intake is fitted between the wings on the underside. The wings are slightly modified and now fold, while the launch rail fittings are on the sides. Few details are available about performance but officials stated that it would be similar to that of the C-801 but capable of a lower terminal phase.

Specifications

YJ-1 (C-801)
Length: 5.81 m (19.06 ft)
Diameter: 36 cm (14.17 in)
Wing span: 1.18 m (3.87 ft)
Propulsion: Rocket motor
Weight: 815 kg (1,797 lb)
Range: 4.5-23 n miles (8-42 km)
Speed: Mach 0.9
Guidance: Inertial and active radar
Warhead: 165 kg (363.7 lb) semi-armour-piercing

YJ-2 (C-802)
Length: 6.39 m (20.96 ft)
Diameter: 36 cm (14.17 in)
Wing span: 1.18 m (3.87 ft)
Propulsion: Turbojet
Weight: 715 kg (1,576 lb)
Range: 14.5-65 n miles (15-120 km)
Speed: Mach 0.9
Guidance: Inertial and active radar

Manufacturers/Contractors

China Precision Machinery Import and Export Corporation (CPMIEC) (missile).
Elbit Ltd, Advanced Technology Center, Haifa, Israel (EW system).

TUBES

Six 533 mm (21 in) bow tubes.

TORPEDOES

18 (a combination of older, straight-running, and more modern Russian homing types).

Specifications

SET-65E
Length: 7.8 m (25.6 ft)
Diameter: 533 mm (21 in)
Power: Electric
Range/speed: 5.4 n miles (10 km) at 35 kts or 10.8 n miles (20 km) at 24 kts
Min range: 0.22 n miles (400 m)
Propellers: 2 (claimed to be wakeless)
Warhead: 205 kg (452 lb)

Type 53-51 (may be 53-56)
Length: 7 m (22.96 ft)
Diameter: 533 mm (21 in)
Power: Air/steam
Range/speed: 5 n miles (9.2 km) at 39 kts or 2 n miles (3.7 km) at 51 kts
Guidance: Pattern running
Warhead: 400 kg (882 lb)

MINES

36 in lieu of torpedoes.

COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Tray

Snoop Tray is an I-band surface search radar of Soviet (Russian) origin. It has a rectangular and only slightly curved antenna.

SONARS

Trout Cheek

Trout Cheek is a somewhat dated Soviet-designed sonar. It is a bow-mounted active/passive search and attack sonar using medium frequencies.

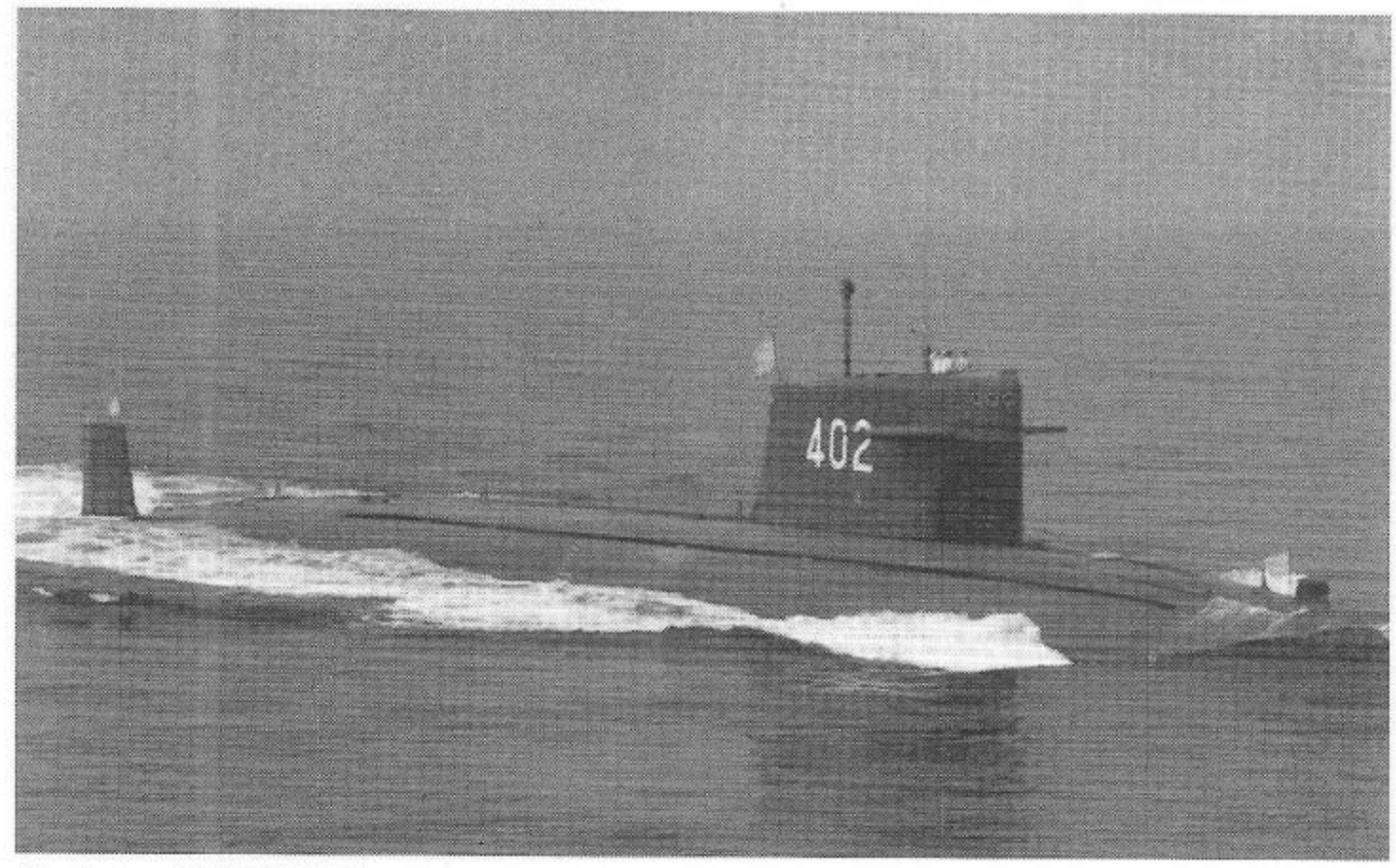
Thomson-Sintra DUUX-5 Fenelon

DUUX-5 is a panoramic sonar capable of automatic, simultaneous tracking of three targets. It incorporates a passive acoustic rangefinder for measuring the range of three targets within 120° sectors, and a panoramic sonar interceptor measuring the true bearing of all

sonar transmissions received in the 2 to 15 kHz band. It enables range and bearing information on targets to be obtained by the submarine without the need for any transmissions and with minimum delay. Speed of operation permits target course and speed to be computed rapidly, also allowing any changes in either speed or course to be detected without delay. Four targets can be tracked simultaneously (three on radiated self-noise, one on sonar pulses), and there is a continuous panoramic bearing display over 360°. Range information is provided over arcs of 120° on each side of the submarine. Target data is automatically transmitted to the ship's weapon control system and plotting table. Under normal conditions, results in the middle sector are 0.3° for bearing accuracy, 2° discrimination accuracy between two targets and 5 per cent of range on radiated noise for a target at 10 km (5.4 n miles) distance. Two types of hydrophones are available. The hydrophonic unit is composed of two bases with three hydrophones each on the starboard and port sides of the submarine. All other technical details remain classified.

Manufacturer/Contractor

Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, France.



'Han' class SSN (CPMIEC)

PROPULSION

Specifications

System: Nuclear
Reactor: 1 pressurised water reactor (PWR); 90 MW
Shafts: 1

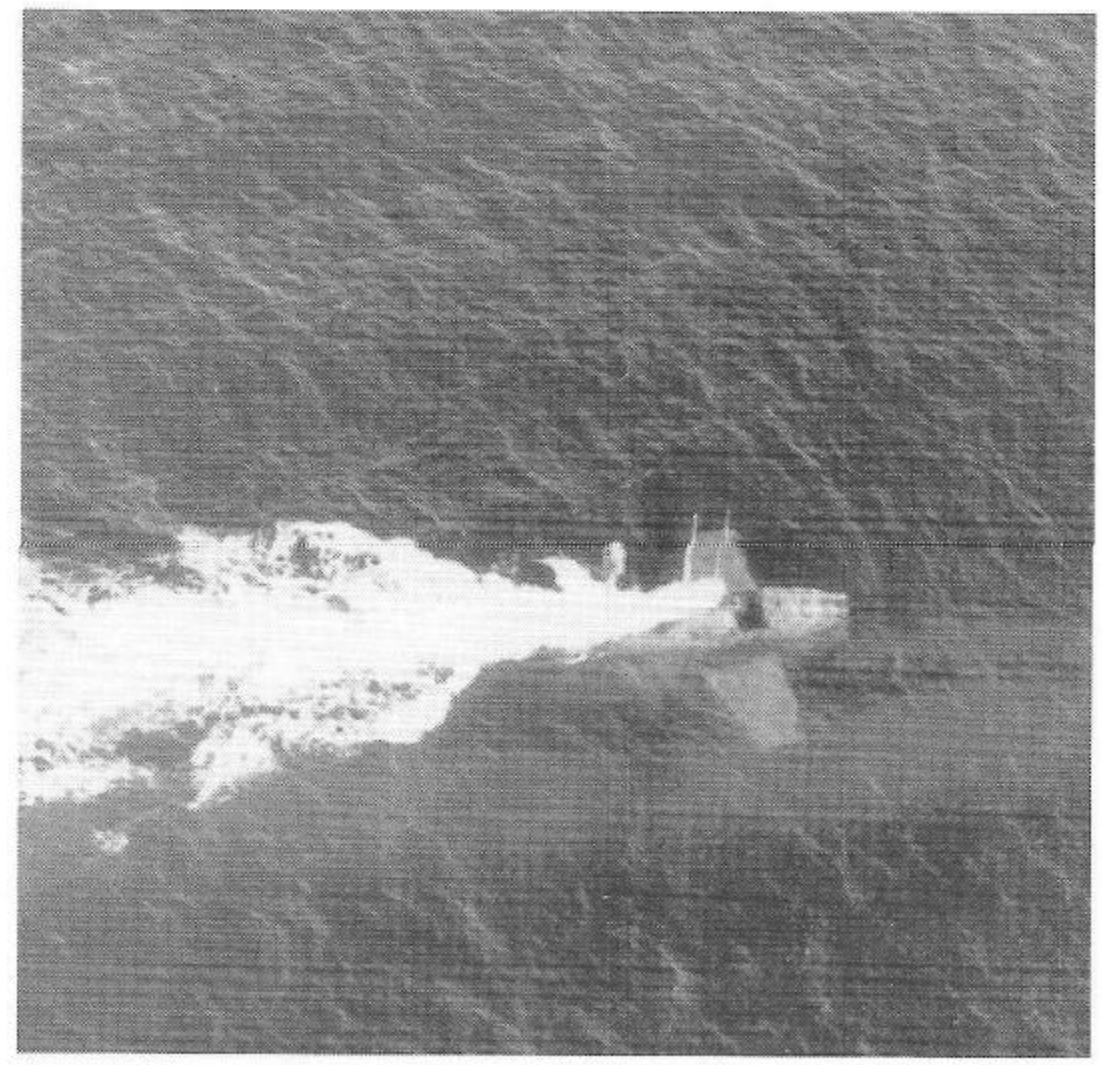
FURTHER INFORMATION

PROGRAMME

The People's Liberation Army - Navy (PLA-N) acquired diesel-electric submarines from the (then) Soviet Union in the late 1940s and started licensed production in the 1950s. The PLA-N was, however, quick to appreciate the importance of nuclear propulsion and a nuclear programme was therefore started in the mid-1950s, leading to the first SSN being laid down in 1968 at the Huludao shipyard. It is believed that it was launched in 1971, although it did not become fully operational until the early 1980s, the delay probably being due to problems with the power plant. Construction then continued slowly with the second hull being launched in 1977, the third in 1983, the fourth in 1987 and the fifth and final one on 8 April 1990. The third and subsequent boats are somewhat longer than the first two and incorporate additional weapons and equipment.

The first pair were thought to be non-operational for a time in the late 1980s but it turned out that they had been undergoing an extensive refit, possibly bringing

'Han' class SSN (US Navy)



Chinese 'Han' class SSN ensuring that it can be seen trailing a US Navy carrier task group in October 1994 (US Navy)

them up to the same standard as the last three. Both are now back in service.

DESIGN

For the PLA-N not only was this its first nuclear-propelled submarine design, but it was also the first hull to replace the traditional long, thin, twin-propeller design (as for example, in the Foxtrots and Romeos it was building under licence) with the shorter, fatter 'Albacore' hull and a single propeller. With so many 'firsts' — and also bearing in mind China's relative inexperience in submarine operations at that time — it is hardly surprising that problems should have been encountered early in the programme.

Although by no means a copy of any other design, the 'Han' class is of classic SSN layout, with an Albacore-type hull, a sail mounted well forward, and forward hydroplanes mounted high on the sail. The few pictures available do not indicate that the hull is covered in acoustic tiles.

From 403 onwards the hull has been extended by some 8 m (26.2 ft) and it is reported that this is to enable Ying Ji SSM tubes to be mounted aft of the fin in a similar manner to the Modified 'Romeo' class SSG. There has, however, been no visual confirmation.

MODERNISATION

The 'Han' class appears to have been one of the Chinese projects to have benefited from commercial co-operation with Western countries. The original and very basic Russian ESM equipment has been replaced by French gear and more recent reports indicate that the SSM fitted hulls have been equipped with more modern ESM, of Israeli origin, possibly for long-range targeting. A French intercept sonar set has also been fitted.

OPERATIONAL

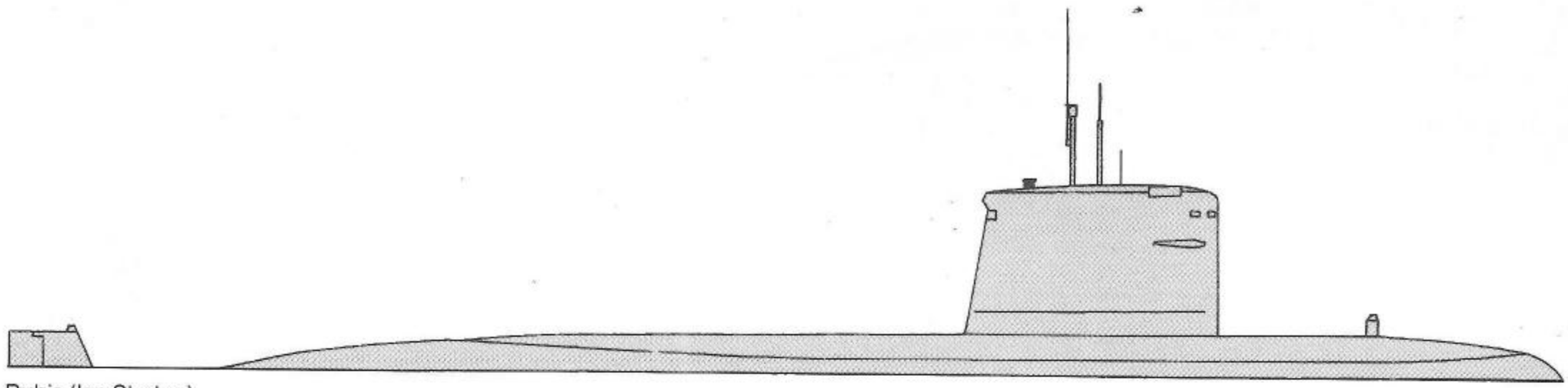
These submarines are all in the North Sea Fleet. One of the class tracked a USN carrier battle group operating off North Korea on 27-29 October 1994. The carrier USS *Kitty Hawk* was sailing through the Yellow Sea en route to the South Korean port of Kwangju when a patrolling S-3 Viking operating some 450 n miles (832.5 km) from the carrier detected (or was directed to) the submarine, which was running at periscope depth in the general direction of the carrier. The submarine eventually came within 21 n miles (38.8 km) of the carrier before turning away, but it seems clear that the submarine intended to be seen in a display of confidence on the high seas, not demonstrated before.

Those submarines in the class armed with JL-1 SSMs have to surface to fire their missiles, which would be a tactical disadvantage in a conflict with an advanced naval power, but less so in a confrontation with another Asian navy.

THE FUTURE

A successor class is being worked on with assistance from one of Russia's leading design bureaux, the Rubin Design Bureau in St Petersburg. Rubin is also working with the Huludao yard on the 'Kilo' class, a number of which have been purchased by China.

RUBIS AMETHYSTE



Rubis (Ian Sturton)

GENERAL SPECIFICATIONS

Country: France
Designation: *Sous-marin Nucléaire d'Attaque (SNA)*

Class: RUBIS AMETHYSTE

Built: 6
Active: 6
Building: 0

Displacement:
surfaced: 2,385 t (S 601-S 604); 2,410 t (S 605-S 606)
submerged: 2,670 t

Dimensions
Length:
S 601-S 604: 72.1 m (236.5 ft)
S 605-S 606: 73.6 m (241.5 ft)

Beam: 7.6 m (24.9 ft)
Draught: 6.4 m (21 ft)

Speed, submerged: 25 kts
Diving depth: Greater than 300 m (984 ft)

Complement: 70 (8 officers) (2 crews)

SUBMARINES

RUBIS (S 601)

Builder	DCN, Cherbourg, France
Laid down	11 Dec 1976
Launched	7 Jul 1979
Commissioned	23 Feb 1983

SAPHIR (S 602)

Builder	DCN, Cherbourg, France
Laid down	*1 Sep 1979*
Launched	1 Sep 1981
Commissioned	6 Jul 1984

CASABIANCA (S 603)

Builder	DCN, Cherbourg, France
Laid down	19 Sep 1979
Launched	22 Dec 1984
Commissioned	21 Apr 1987

EMERAUDE (S 604)

Builder	DCN, Cherbourg, France
Laid down	*1 Mar 1983*
Launched	12 Apr 1986
Commissioned	16 Sep 1988

AMETHYSTE (S 605)

Builder	DCN, Cherbourg, France
Laid down	11 Oct 1984
Launched	14 May 1988
Commissioned	20 Mar 1992

PERLE (S 606)

Builder	DCN, Cherbourg, France
Laid down	*27 Mar 1987*
Launched	22 Sep 1990
Commissioned	7 Jul 1993

WEAPONS SYSTEMS

SUBMARINE-LAUNCHED ANTI-SHIP MISSILES

Aerospatiale SM 39 Exocet
The SM 39 Exocet anti-ship missile is launched from 533 mm (21 in) torpedo tubes.

Specifications
Length: 5.21 m (17.09 ft)
Diameter: 35 cm (13.78 in)
Wing span: 1.00 m (3.28 ft)
Weight: 660 kg (1,455 lb)
Range: 2-27 n miles (4-50 km)
Speed: Mach 0.9
Guidance: Inertial and active radar
Warhead: 165 kg (364 lb)

Manufacturer/Contractor
Aerospatiale, France.

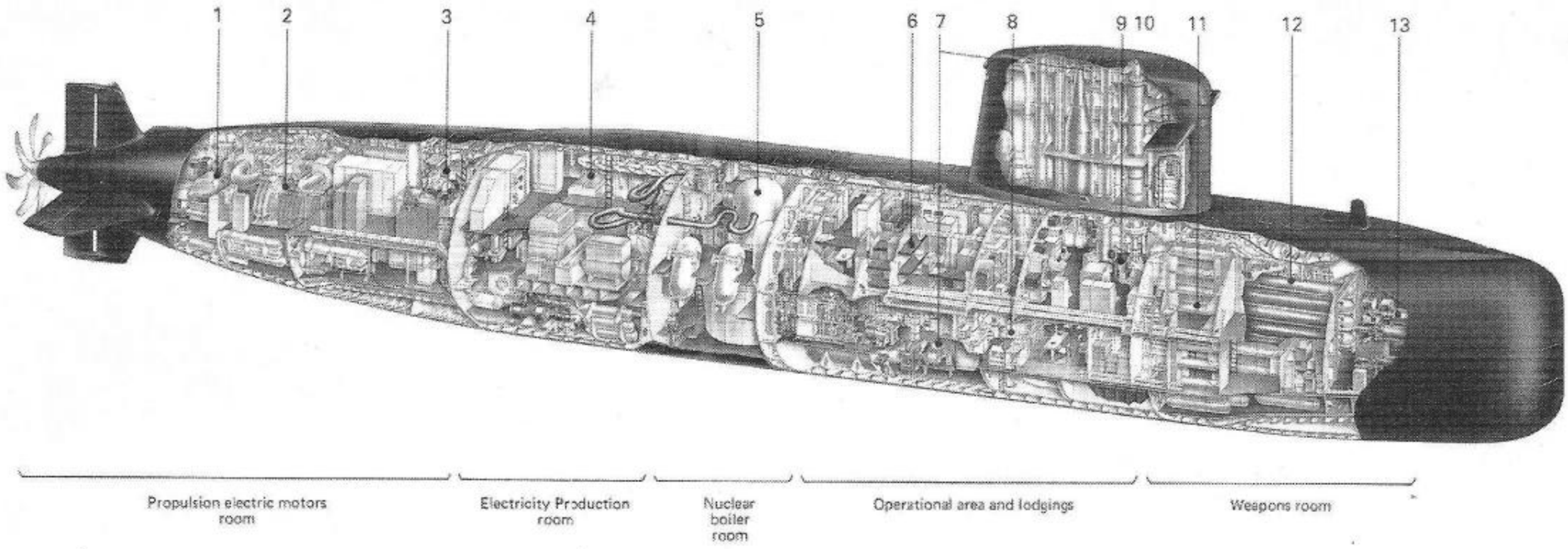
TUBES

Four, bow-mounted, 533 mm (21 in) tubes. Total weapon load, 18 missiles/torpedoes.

TORPEDOES

L5 Mod 3 heavyweight, dual-purpose torpedo
L5 is a heavyweight ASW torpedo, which can be used for direct or indirect attacks. The weapon is of conventional design with blunt nose, four fins and twin contra-rotating propellers. The body is made of a light alloy and the nose of laminated material. All models are electrically propelled with silver/zinc batteries. They have passive/active seekers which have various operating modes including direct attack or programmed search. Mod 3 is the submarine-launched version

Améthyste



1 Emergency electric motor **2** Main electric motor **3** Propulsion machinery control room **4** Turbo-alternators **5** Steam generator **6** Officers' quarters **7** Auxiliary machinery room **8** Galley **9** Operation control room **10** Periscope **11** Crew quarters **12** Ammunition **13** Torpedo tubes

Specifications
Length: 4.4 m (14.44 ft)
Diameter: 533 mm (21 in)
Weight: 1,300 kg (2,866 lb)
Range: 5.1 n miles (9.5 km)
Max speed: 35 kts
Warhead: 150 kg (331 lb)
Depth: to 550 m (1,800 ft)
Homing: Active/passive homing
Propulsion: Electric (silver/zinc batteries)

Manufacturer/Contractor
DCN International, Paris, France.

F17 Mod 2 heavyweight, dual-purpose torpedo
F17 is a submarine-launched heavyweight multirole weapon for use against surface and submarine targets and is compatible with pneumatic rammer, water pulse or swim-out launching systems. In the normal launch procedure, the torpedo is wire-guided during the early part of its run and is given commands on course and depth to be achieved at the end of the wire-guided operation from the submarine. During the terminal phase the torpedo uses passive search only throughout attacks against surface ships, but against submarine targets the passive mode is used until the terminal phase when the seeker goes active.

Specifications
Length: 5.4 m (17.7 ft)
Diameter: 533.4 mm (21 in)
Weight: 1,406 kg (4,000 lb)
Range: 10.75 n miles (20 km)
Max speed: 28/40 kts
Warhead: 250 kg (551 lb) HBX3
Fuzes: Contact and magnetic
Depth: 6-20 m (20-66 ft) against surface ships; 30 m (98.5 ft), 100 m (328 ft), 200 m (656 ft) against submarines
Guidance: Wire and automatic passive/active homing
Propulsion: Electric (silver/zinc batteries)

Manufacturer/Contractor
DCN International, Paris, France.

MINES

FG 29 Mines
Up to 32 FG 29 mines can be carried in lieu of torpedoes. The FG 29 mine is laid from the submarine's torpedo tubes and has multi-influence detectors. It is fitted with an arming delay and an anti-sweep device, and is designed to resist explosion-based minesweeping methods.

Specifications
Length: 3 m (9.84 ft)
Diameter: 520 mm (20.4 in)
Weight: 1,000 kg (2,205 lb)
Explosive: 600 kg (1,323 lb)
Max depth: 300 m (984 ft)
Fuzing: Magnetic, acoustic, pressure

Manufacturers/Contractors
DCN, Paris, France (prime).
Thomson-Sintra, Paris, France (sensors).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

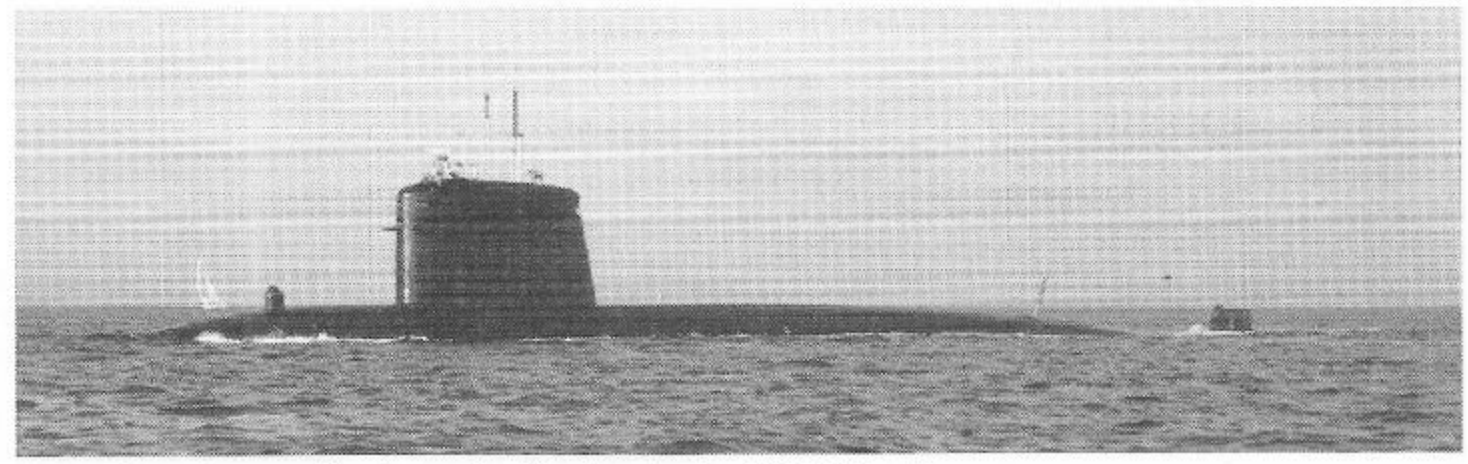
DR 3000U ESM Receiver
The DR 3000U ESM receiver offers threat detection, direction-finding, identification and target designation of enemy radars over the C- to J-frequency bands. The system uses the latest advances in gallium arsenide (GaAs) technology and is of modular and lightweight design. It has a high sensitivity range covering the breadth of the frequency spectrum, with a detection capability of nearly 100 per cent. Direction-finding accuracy is understood to be in the order of 6°. Highly automated operation includes the use of artificial intelligence and allows for very short reaction times. The DR 3000U includes a 5 kg (11 lb) periscope aerial; or a 12 kg (26.4 lb) small direction-finding (DF) aerial with six DF antennas (2 to 18 GHz); or a more sophisticated system consisting of GPS and a 30 kg (66.15 lb) DF aerial.

Specifications
Frequency: C- to J-bands
Azimuth coverage: 360°
Elevation coverage: −10 to +45°
Sensitivity: −68 dBm
Dynamic range: Up to 60 dB
Radar modes: 4,000 in library

Manufacturer/Contractor
Thomson-CSF, Radars and Countermeasures Division, Elancourt, France.

COMMAND AND CONTROL SYSTEMS

Système d'Armes Tactique (SAT)
The development of the Améthyste (AMElioration Tactique HYdrodynamique Silence Transmission Ecoute) upgrading programme for the 'Rubis' class SSNs, which included the new DSUV 62 towed array sonar and the replacement of the DSUV 22 by the DMUX 20 led to a need for a new command and control system: the SAT. The Améthyste programme introduced a federated architecture with three subsystems, Detection Sous-Marine (DSM), the Traitement des Informations Tactiques (TIT) and the Lancement des Armes Tactiques (LAT), linked by two digital databuses. It is believed they can track up to 20 targets automatically and 30 manually, while conducting target motion analysis (TMA) on four. Two torpedoes may be controlled simultaneously. The DSM subsystem has passive surveillance sonars with two processor cabinets and a graphic monitor while the ranging/intercept and active sonars have their own processing cabinets. These feed data to two double-screen operating consoles while the towed array antenna has its own console and processing electronics cabinet.



Rubis, *following modification to* Améthyste *standard* (H M Steele)

The DSM is linked via the TIT databus to the TIT tactical data handling subsystem which uses sensor data to perform tactical picture compilation and TMA which is then displayed and, when necessary, used for target designation to the LAT subsystem. The TIT is a mainframe system consisting of a computer with disk-based mass memory unit cabinet and printer unit. It is directly linked to an automatic plotting table. It is linked to two single-operator display systems through a coupling device cabinet. This interfaces with both the TIT and the LAT databuses, the LAT subsystem being the DLA 3.

Among other features, the new combat system enables two F17 torpedoes to be guided simultaneously against separate targets.

COMMUNICATIONS

Syracuse 2 Satcom.

RADAR

DRUA-33

DRUA-33 radar (also known as Calypso) carries out airspace and surface surveillance while the submarine is on the surface, and is also used for navigation. There is a single operating console below and the rotating antenna is positioned atop a mast to give maximum coverage. An earlier version, Calypso III, is quoted as being able to detect a 10 m^2 target, such as an ASW aircraft, at 18 n miles (33.3 km) and a height of 2,500 m (8,200 ft).

Specifications

Role: Surveillance and navigation
Frequency bands: I/J band
Pulse: 1 ms
Range: Min 10 n miles (18.5 km)
Peak output power: 25 kW

Manufacturer/Contractor

Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

Interior view of Rubis (DCN)

SONARS

DMUX 20

This is a multifunction, passive search, low-frequency sonar, which is part of the Améthyste upgrade. No details are available.

DUUA 2b

The DUUA 2b active sonar has a frequency of 8 kHz and a power of 3 kW. Narrowband receiver coverage is ±500 Hz around any selected frequency between 2 and 15 kHz while broadband coverage is between 2.5 and 15 kHz.

Manufacturer/Contractor

Thomson-CSF, Paris, France.

DUUX 5

DUUX 5, sometimes called Fenelon, is a passive ranging and intercept sonar, consisting of two arrays of three hydrophones on each side of the submarine. It operates in the 2-15 kHz band, with range information being provided over arcs of 12° and automatically transmitted to the SAD. Up to four targets are tracked simultaneously (one on sonar pulses and the others on radiated noise). Bearing accuracy can be down to 0.3° and discrimination accuracy to 2°.

Manufacturer/Contractor

Thomson-CSF, Paris, France.

DSUV 62C

DSUV 62C is a towed, passive sonar array and is designed to enable SSNs to track a contact and to provide data for the fire-control system.

Manufacturer/Contractor

Thomson-CSF, Paris, France.

PROPULSION

Specifications

System: Nuclear, turbo-electric
Reactor: 1 CAS 48 pressurised water reactor (PWR); 48 MW
Turbo-alternators: 2
Electric motor: 1—7 MW (9,500 hp(m))
Auxiliary system: SEMT-Pielstick/Jeumont Schneider 8 PA4 V 185 SM diesel-electric auxiliary propulsion; 450 kW; 1 emergency motor
Shafts: 1

FURTHER INFORMATION

PROGRAMME

All other nuclear navies developed SSNs first and then turned to SSBNs, primarily because nuclear propulsion technology was ahead of missile technology, but in France the pressure of President De Gaulle's strategic imperatives forced the navy to do it the other way around. Not surprisingly, the SSBN programme was so demanding that it was not until 1974 that the French Navy was able to turn its attention to attack submarines, with the first of class, *Rubis,* being laid down in December 1976, launched in 1979 and, following extensive trials, joining the fleet in 1983.

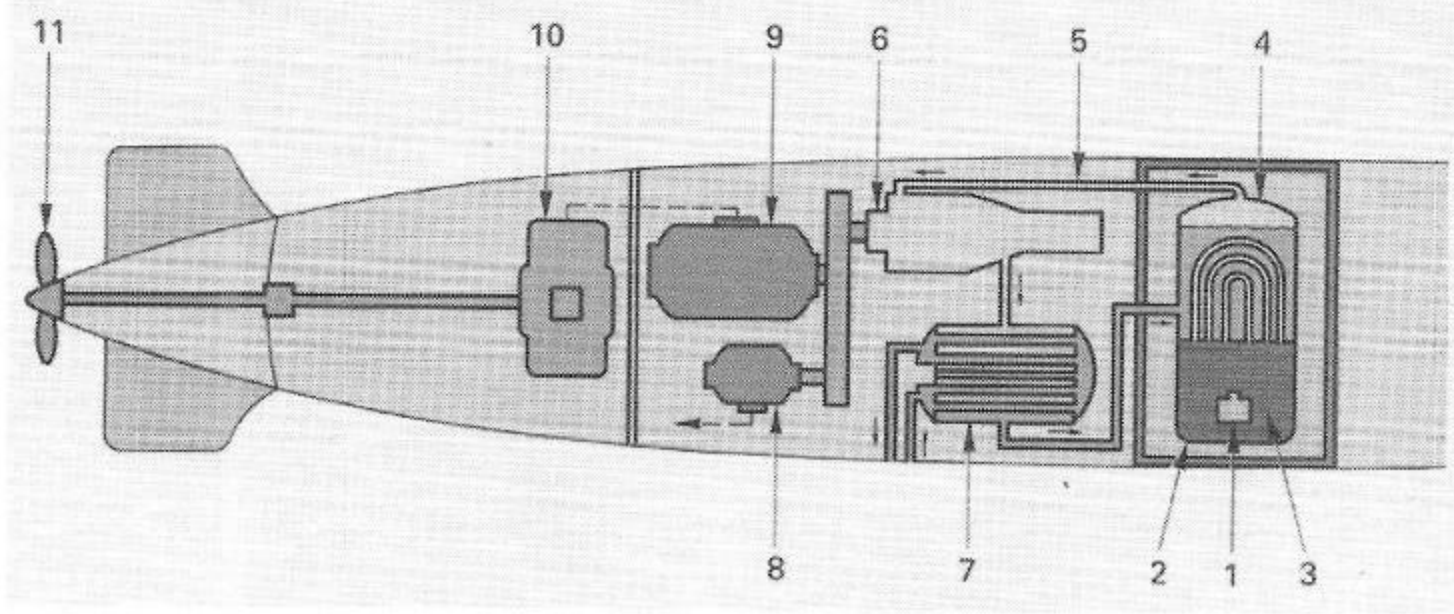
The 'Rubis' class (also known as SNA72) are the smallest SSNs in any navy and the hull design, armament, sonar and fire-control systems were closely based on those of the 'Agosta' class diesel-electric submarines. Despite its small size (or possibly because of it) the Rubis design proved to be surprisingly noisy, which led to the Améthyste programme (AMElioration Tactique HYdrodynamique Silence Transmission Ecoute), which was introduced into the fifth of class (coincidentally also called *Améthyste*) and the sixth, *Perle,* while building. The Améthyste programme also involved changes to sonar and other ASW equipment to match the change in role from anti-ship to anti-submarine.

It was originally intended to have eight boats of this class, but the programme for the French Navy was terminated early due to defence economies, with *Perle* (S 606) being the sixth and last for the French Navy. The seventh of class (which would have been named *Turquoise*) may either be completed for export as a diesel-electric boat, or used for the trials of the MESMA air-independent propulsion (AIP) system. The eighth of class, *Diamant,* was cancelled.

In the late 1980s the Canadian Navy held a competition for the supply of up to 12 SSNs, for which the French bid was a design based on that of the Rubis. The competition was fiercely fought but in the end it was cancelled by the Canadian Government.

Nuclear fuel (1) contained in reactor vessel (2) boils the primary water (3). This water circulates by natural convection into the steam generator (4) and allows the evaporation of the secondary water (5) to feed the turbines (6). The secondary water is cooled in the condenser (7) before being returned into the steam generator. Each turbine transmits motion to two alternators (8) and (9). The propulsion alternators (9) produce the electricity necessary to the main electric motor (10) that swings the propeller (11) directly. Power alternators (8) provide the necessary electricity to the ship installations.

The nuclear boiler is confined in a strictly supervised and protected independent compartment.



DESIGN

These are the smallest operational SSNs to be designed; only the US Navy's 400 t NR-1 research submarine is smaller. It is thus clear that there has been a marked reduction in the size of the reactor compared with the 'Le Redoutable' class, which appears to have been achieved by integrating the nuclear reactor and the heat exchanger, coupled with the use of turbo-electric drive.

The overall design is similar to that of the diesel-electric 'Agosta' class, but the 'Rubis' class is of single-hull construction and uses Marel steel.

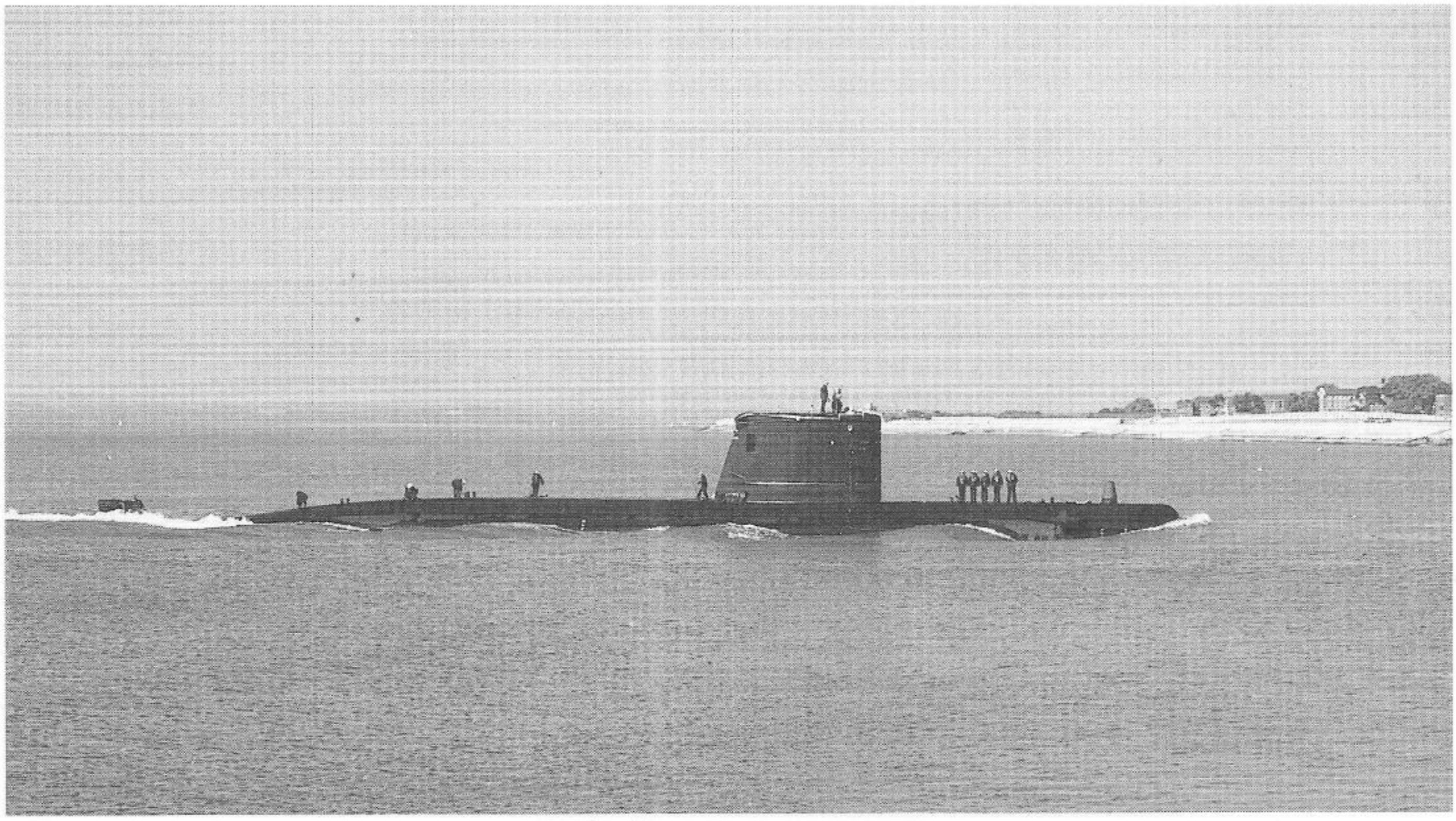
MODERNISATION

As built, *Améthyste* and *Perle* were longer than the first four boats: 73.6 m (241.5 ft) as opposed to 72.1 m (236.5 ft). They were also built to a modified design, which included a new bow form, a new design sonar (DMUX 20), a DSUV 62C towed array sonar, a major silencing programme, a streamlining of the superstructure as well as new tactical and attack systems and improved electronics and the Syracuse 2 Satcom system. The fifth and sixth having been built to this new standard, the first four boats were subsequently retrofitted to the same equipment and silencing standard between 1989 and 1995, the new bow section increasing their length to match that of *Améthyste*. *Saphir* recommissioned in July 1991, *Rubis* in February 1993; *Casabianca* in June 1994 and *Emeraude* in late 1995.

OPERATIONAL

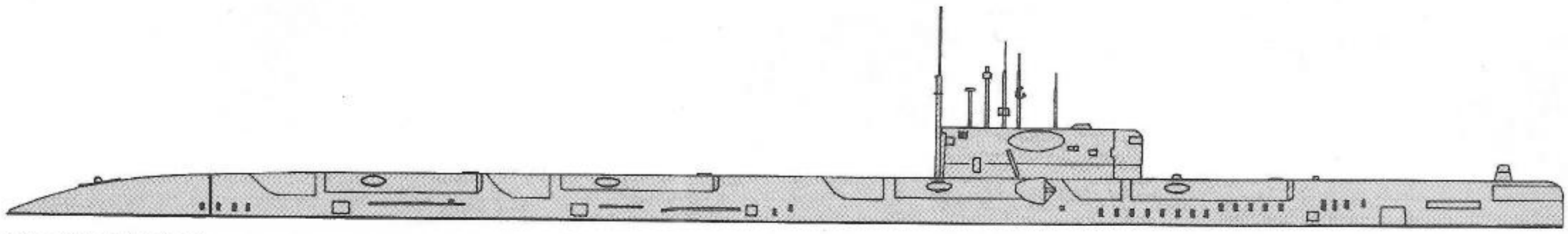
All operational SSNs are based at Toulon but frequently deploy to the Atlantic. Uniquely among SSNs they have been operated with two crews, thus significantly increasing their utilisation rate, although whether this will continue to be possible when the 1996 defence cuts are implemented remains to be seen. Their endurance is limited to 45 days by the stock of food that can be carried, although this can be extended to 60 days if operationally necessary.

Rubis collided with a tanker on 17 July 1993 and had to undergo extensive repairs. *Emeraude* suffered a serious steam leak on 30 March 1994 while submerged, which caused ten deaths among the crew. The casualties were in the compartment containing the two turbo-alternators and were not, in any way, associated with the nuclear plant.



Améthyste, *first of the newer and quieter versions* (Jane's/H M Steele)

ECHO II



Echo II (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia

Class: ECHO II (TYPE 675M) (SSGN)

Built: 29
Active: 2
Building: 0

Displacement:
surfaced: 4,800 t
submerged: 5,800 t

Dimensions
Length: 119 m (390.4 ft)
Beam: 9.2 m (30.2 ft)
Draught: 6.9 m (22.6 ft)

Speed:
surfaced: 18 kts
dived: 24 kts
Diving depth: 200 m (650 ft)

Complement: 90

WEAPONS SYSTEMS

TUBES

Four/six 533 mm (21 in) bow tubes.
Four 406 mm (16 in) stern.

SURFACE-TO-SURFACE MISSILES (SSM)

SS-N-12 (NATO = Sandbox)
(Russia = 4K80 Bazalt)

Eight SS-N-12 missiles. This missile has a slim cylindrical body with a sharply pointed nose and a small, ventrally mounted air intake under the delta-shaped, shoulder-mounted wings. The missile uses two, solid-propellant rocket boosters to clear the launcher, where the folding wings deploy and it enters the cruise phase, where the turbojet takes over. The tail empennage consists of two low-set horizontal stabilisers and a ventral fin.

The missiles are large, no less than 11.7 m (38.38 ft) long and weighing some 4.6 t (rather more than a four-seater Cessna Skylane, for example) and are mounted in individual launch tubes located between the pressure hull and the outer casing. The submarine must surface, raise the tubes to an angle of 20° and then open the front and rear doors, before it is ready to fire. The casing behind the rear door is strengthened to prevent damage from the hot gases of the booster. The fire-control system is described below.

The missile is capable of adopting either high- or low-altitude cruise profiles, provided only that it remains within line of sight to the submarine until the missile has locked on to the target.

Specifications
Length: 11.7 m (38.38 ft)
Diameter: 88 cm (2.88 ft)
Wing span: 2.1 m (?) (6.89 ft)
Weight: 4,600 kg (10,141 lb)

Speed: Mach 1.7
Range: 296 n miles (550 km) with over-the-horizon (OTH) targeting
Cruise altitude: 10,688 m (35,000 ft)
Guidance: Inertial (with command updates) and active radar homing
Warhead: 1,000 kg (2,204 lb) HE or 350 kT nuclear

Manufacturer/Contractor
Mashinostroyenie Research and Product Organisation.

TORPEDOES

A combination of 533 mm and 406 mm torpedoes; Total number 20.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Stop Light
Stop Light is a broadband, passive ESM system, probably with an ELINT function.

Brick Pulp or Squid Head
Brick Pulp and Squid Head are ESM systems, presumably used for surveillance and threat warning and it appears that one or other is installed.

Quad Loop
Quad Loop is a DF antenna.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Front Piece/Front Door
Front Piece and Front Door are F-band (3-4 GHz) antennas, which are part of the fire-control system and are mounted in the top of the sail. When not in use the Front Piece antenna hinges backwards into a long rectangular well at the forward end of the sail, which has displaced the surface watchkeepers from their customary position. In use, the Front Piece antenna is raised and the entire forward section of the fin rotates to expose the Front Door antenna. These antennas provide mid-course guidance for the SS-N-12 missiles which are launched in ripples of up to four missiles. The system is limited to dealing with four missiles at a time, so that a second salvo cannot be fired until the first has locked on for its terminal attack, which would leave the submarine very exposed.

Target data can be acquired from the submarine's Snoop Slab search radar, but it is more usual for them to come from satellites, from a Tu-95 'Bear D' ASW aircraft, or, if a surface ship happens to be in area, from a Ka-25 'Hormone B' or Ka-27 'Helix B' helicopter fitted with Big Bulge I/J-band radar. The procedure is for the submarine to be ordered by HF or LF links to come to periscope depth, where it exposes its communications mast to receive targeting information. If the captain decides to engage, the submarine carries out a 'combat approach' and then surfaces whilst still below the target's horizon and fires a ripple of up to four missiles. Guidance updates are provided by the mission controller in the submarine, using the Front Door/Front Piece communication system and when in range he orders the missile's own search radar and transmitters to switch on. The missile starts feeding a radar picture back to the submarine and once its radar has locked on to the selected target the operator orders the missile to start the homing phase and to switch off its rear-link radio.

One of the apparent limitations of the system is that the missile controller cannot launch a second salvo until the communications link from the first salvo has been switched off as the missiles start their homing phase. This suggests that it could take up to 20 minutes to launch all their missiles, during which the submarine would be vulnerable to attack.

RADAR

Snoop Slab
Snoop Slab is an I-band surface search radar, mounted on its own mast. It has a large parabolic antenna, mounted atop a large cylindrical electrical drive unit. The size of the antenna is presumably intended to give good definition at long ranges.

SONAR

Shark Teeth
Shark Teeth is a hull-mounted, medium-frequency, passive/ active, search and attack sonar.

PROPULSION

Specifications
System: Nuclear
Reactors: 2 VM-A pressurised water reactors (PWR)
Power output: 13 MW (17,500 hp(m))
Turbines: 2
Power output: 22 MW (30,000 hp(m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The two remaining 'Echo II' class submarines are all that are left of a class of 29, which, in their day, represented a substantial part of the Soviet Navy's offensive anti-ship potential, their tactical mission being to attack enemy (such as, NATO) carrier battle groups. First to be built were five Echo Is which were equipped with three pairs of SS-N-3 launch tubes, but these tubes were later removed and the submarines converted for use as SSNs. The first of the 'Echo II' class appeared in 1963 with a longer hull accommodating an extra pair of SS-N-3 launchers and 29 were launched at Severodvinsk and Komsomolsk between 1963 and 1969.

Subsequently, 14 Echo IIs were converted to take the SS-N-12 missile and the unmodified Echo IIs had all been paid off by 1993.

DESIGN

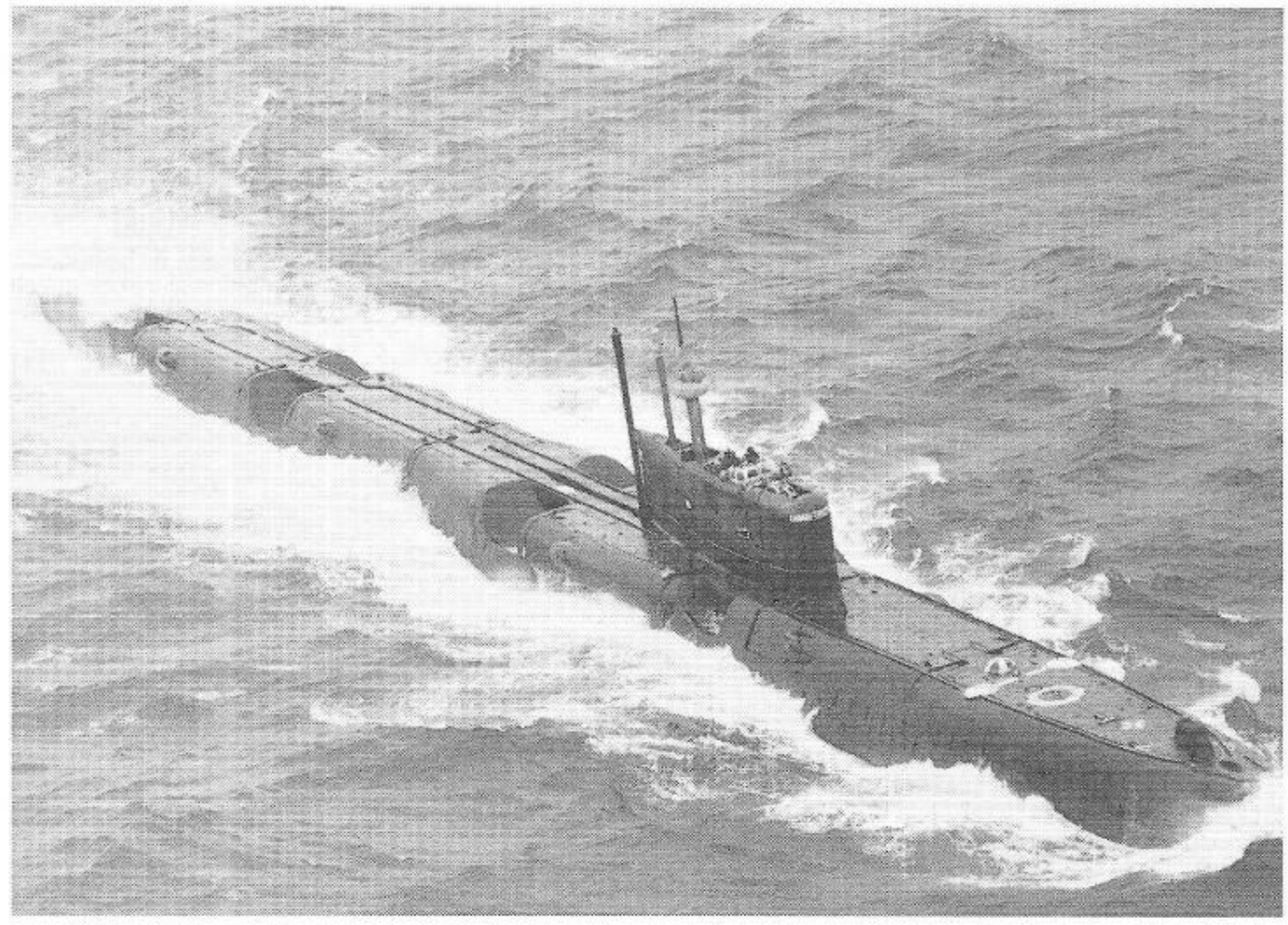
The 'Echo' class has a long, narrow hull, with two propellers, which, coupled to the huge, uncovered blast recesses makes for a relatively slow and exceptionally noisy submarine. The original Echo I was 110.0 m (360.9 ft) long and the hull was lengthened by precisely 5 m (16.4 ft) to accommodate the extra pair of launchers.

Externally, apart from the extra launch bins, the modifications included a bulged fairing, which was added to the forward end of the forward launch bin, for reasons still unknown. The 'Echo II' also received new fairings either side of the fin related to the Punch Bowl satellite communications system, for which the main antenna is housed in the fin and raised like any other mast.

At the after end of the fin there is a hinged communications aerial which stows in a depression in the casing. In addition, Snoop Tray search radar was replaced by the more modern Snoop Slab. There is no acoustic coating.

OPERATIONAL

The remaining two boats are based in the Northern Fleet where they are used to launch their SS-N-12 missiles to act as targets for fleet air defence systems. One Echo II served for a time as the mother ship for the 'X-Ray' class deep-sea diving trials submarine, but this role has now ceased.



Russian Navy Echo II SSGN

ACCIDENTS

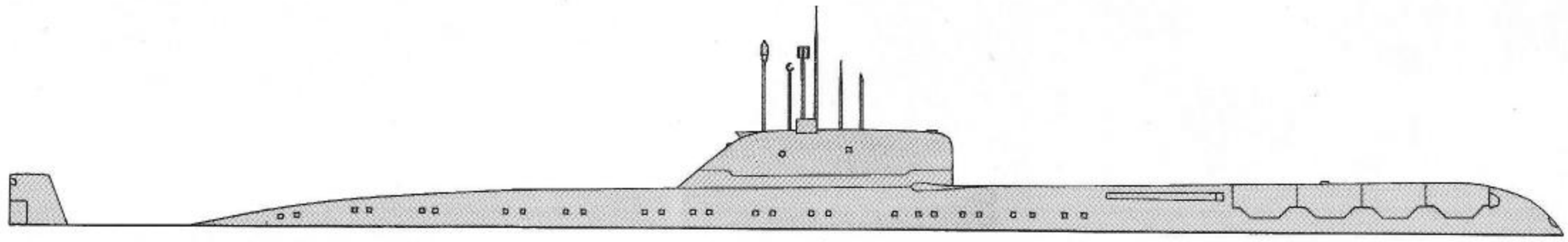
This class has suffered more than its fair share of accidents in which at least 43 sailors are known to have died, although the actual figure may well have been much higher. Surprisingly, no less than four of these incidents have been navigational. Two hit (or were hit by) American warships, one colliding with the 'Sturgeon' class nuclear submarine, USS *Tautog* (SSN-639), in 1970 and the second with the destroyer-escort USS *Voge* (DE-1047) in 1976. There was also a collision with the Russian research ship *Akademik Berg* in 1973 and another collision, this time with an unspecified underwater object, in 1979 in which the *Echo II* was very nearly lost. There have been three major, presumably mechanical, problems: a turbine failure in 1965, an 'internal accident' in 1980 which led to the submarine being towed rather publicly back to Vladivostok, and a major fire in another in 1984.

Most seriously, however, there have been at least four major nuclear problems. One boat suffered a reactor meltdown at sea in 1979, and two were in harbour, one while refuelling at Vladivostok in 1985, the other in Cam Ranh Bay in 1986.

Clearly the most serious, however, was the incident in 1989 when one boat suffered a major leak, believed to have been in the reactor primary loop, which led to the decision to retire all submarines powered by the 'HEN-type' reactors.

Finally, one sank in the Kola Gulf in 1968 for reasons which have never been explained, and which could have been either navigational, mechanical, or, perhaps the most likely, a reactor problem of some sort.

CHARLIE II



Charlie II (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia
Designation: *Podvodnaya Lodka Atomnaya Raketnaya Krylataya (PLARK)*

Class: CHARLIE II (SKAT M) (TYPE 670M)

Built: 6
Active: 2
Building: 0

Displacement:
surfaced: 4,500 t
submerged: 5,550 t

Dimensions
Length: 102 m (334.6 ft)
Beam: 9.9 m (32.5 ft)
Draught: 7.8 m (25.6 ft)

Speed, submerged: 25 kts
Diving depth: 300 m (1,000 ft)

Complement: 90

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

SS-N-9 (NATO = Siren) (Russia = 4K85)

Eight SS-N-9 (NATO = Siren) (Russia = 4K85) missiles are mounted in launch tubes located outside the pressure hull. Some reports indicate that target locations for 'Charlie' class submarines are acquired through the ocean surveillance network, with detailed data being transmitted by high-frequency radio, which would entail the submarine coming close to the surface. Although the submarines have Snoop Tray I-band radar it is also reported they use the mast-mounted Bald Head for fire control. This is a cylindrical radome with 32 directional ports arranged in four tiers, each covering a specific frequency band: D (1-2 GHz), E/F (2-4 GHz), G/H (4-8 GHz) and I/J (8-20 GHz). Below this is the Snoop Head radar and ESM antenna, and below that are four directional antennas for a fast-reaction radar warning receiver. The radar warning receiver provides early warning of the presence of enemy anti-submarine forces and the cylindrical array is used to obtain a rough bearing on the target. More precise data is obtained by using the Snoop Head antenna in ESM mode and the antenna is then used very briefly in the active mode for ranging. The data is then fed to the missile autopilot.

The fire-control system can also receive offboard data through Fish Bowl or Light Bulb datalinks which may also be used in providing mid-course guidance. Offboard data may be provided both by other ships and by Ka-25 'Hormone C' or Ka-27 'Helix B' helicopters which could perform over-the-horizon targeting. The missile is designed to be launched at distances of 25 to 35 n miles (46 to 65 km) beyond the protective ring of aircraft carrier escorts and on launch the missile climbs to about 100 m and uses its radar to acquire the target. At a distance of about 5.5 n miles (10 km) the missile drops to about 90 m and finally makes a low-angle dive onto the target.

Specifications

Length: 8.84 m (29.0 ft)
Diameter: 76 cm (2.49 ft)
Weight: 3,300 kg (7,275 lb)
Wing span: n/k
Range: 60 n miles (110 km)
Speed: Mach 0.9
Guidance: Autopilot with active radar, complemented by IR
Warhead: Nuclear 250 kT or HE 500 kg

TUBES

Four 533 mm (21 in) tubes.
Two 650 mm (25.6 in).

TORPEDOES

A combination of Russian 533 mm and 650 mm torpedoes is carried.

SS-N-15 (NATO = Starfish)

SS-N-15 (Starfish) long-range anti-submarine weapon system is believed to be similar in shape to SUBROC, having a long, slim cylinder with small, retractable fins and a booster rocket at the end. SS-N-15 is associated with a low-frequency, bow-mounted, active/passive sonar system with 6 m (19.6 ft) diameter array (NATO = Shark Teeth). The weapon is loaded into a standard 533 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere, where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-15 payload is either a 200 kT nuclear depth charge or a Type 40 lightweight torpedo although it should be noted that, under current international agreements, nuclear warheads would not be carried at sea; the capability, however, remains.

Specifications

Length: 6.5 m (21.33 ft)
Diameter: 533 mm (21 in)
Wing span: n/k
Weight: 1,800 kg (3,968 lb)
Range: 24-27 n miles (45-50 km)
Speed: n/k
Guidance: Inertial

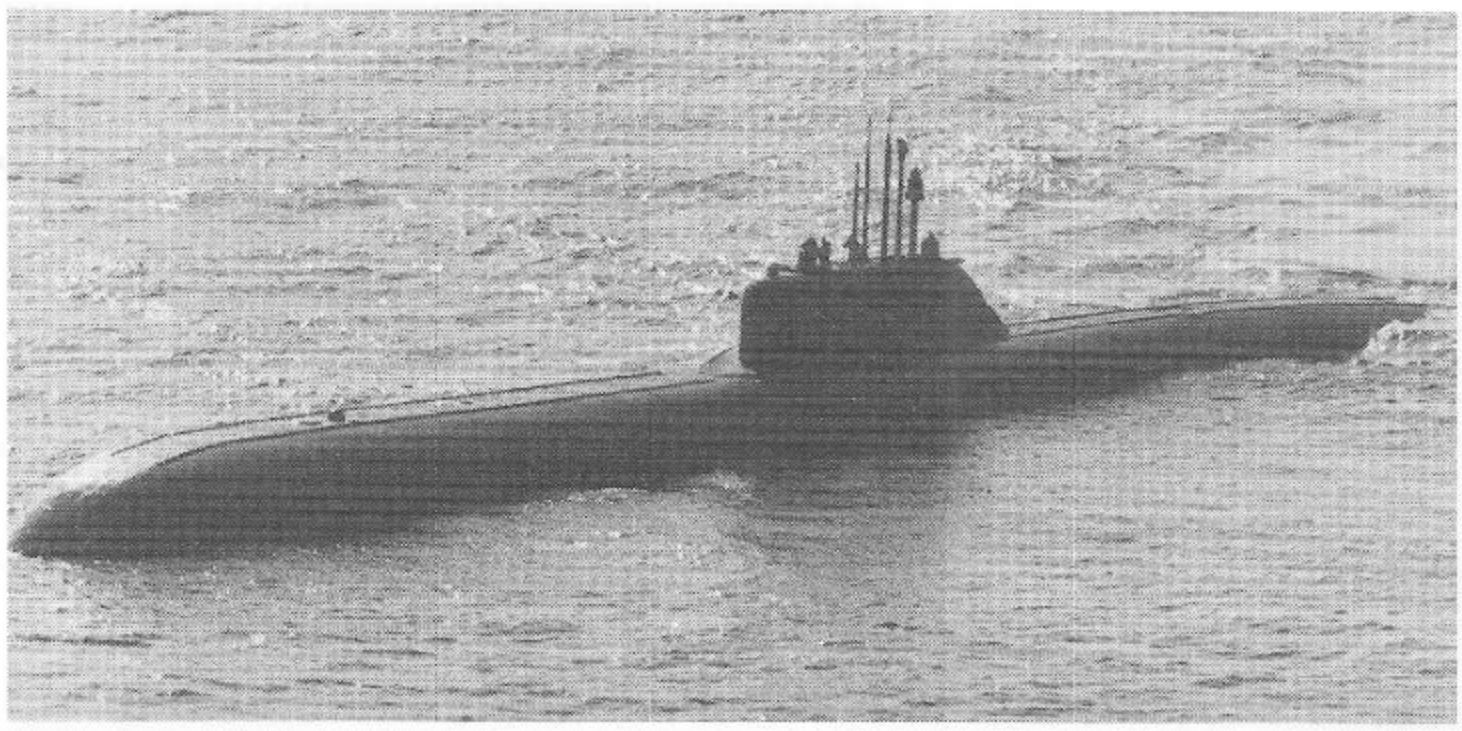
SS-N-16 (NATO = Stallion)

SS-N-16 (Stallion) is a 650 mm tube-launched missile associated with the Shark Gill sonar system, which is integrated with a passive, towed array sonar. The weapon is loaded into a standard 650 mm torpedo tube and then, like SS-N-15, is launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere, where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern.

The SS-N-16 payload is usually an E45-75A lightweight torpedo with a range of 8.1 n miles (15 km) at 30 knots. The torpedo has both passive and active sonar sensors and a warhead of either 100 kg (some sources say 90 kg) high explosives (SS-N-16A Veder) or a nuclear warhead of undetermined power (SS-N-16B Vodopod), although under current international agreements, nuclear warheads would not be carried at sea, but the capability, of course, remains.

Specifications

SS-N-16
Length: 6.7 m (21.98 ft)
Diameter: 650 mm (25.61 in)
Wing span: n/k
Weight: 1,850 kg (4,078 lb)
Range: 50 n miles (92 km)
Speed: n/k
Guidance: Inertial



Russian Navy Charlie II SSN

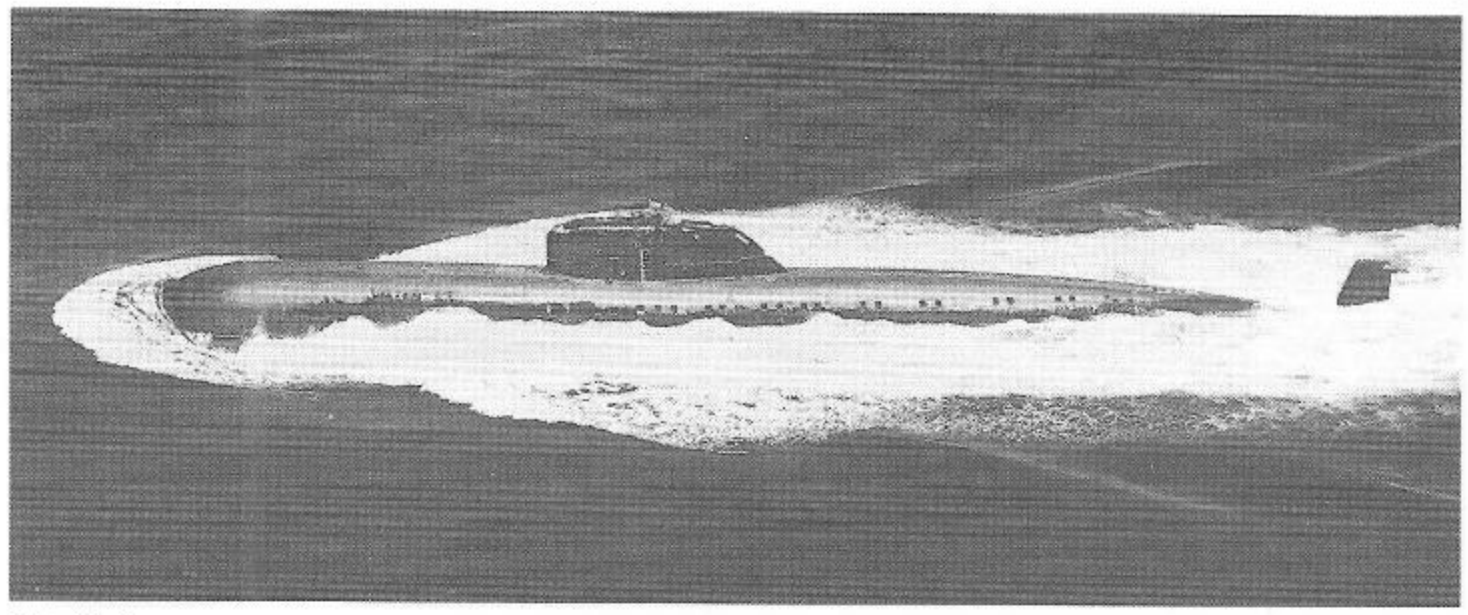
ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Stop Light
Stop Light is a broadband, passive ESM system, probably with an ELINT function.

Brick Spit/Brick Pulp
Brick Spit and Brick Pulp are ESM systems, presumably used for surveillance and threat warning.

Park Lamp
Park Lamp is a mast-mounted VLF/LF receiving antenna, consisting of two open loops at right angles to each other.



Charlie II

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS

VLF communications buoy.
Pert Spring Satcom.
Kremmny 2 IFF.

RADAR

Snoop Tray is a mast-mounted, I-band, surface search radar antenna.

SONARS

Shark Fin
Shark Fin is a hull-mounted, active/passive search and attack sonar, operating at low and medium frequencies.

Mouse Roar
Mouse Roar is a hull-mounted, high-frequency, active attack sonar.

PROPULSION

Specifications
System: Nuclear
Reactors: 2 VM-4P pressurised water reactors (PWR); 150 MW
Steam turbine: 1 GT3A; 13.8 MW (18,800 hp(m))
Shafts: 1

FURTHER INFORMATION

PROGRAMME

The Soviet Navy quickly recognised the shortcomings of the 'Echo II' class and the next class of SSGN was designed to overcome those faults. The 'Charlie I' class had much the same hull form as the Victor I SSN although somewhat slower, and was fitted with eight launch tubes for the SS-N-7 missile. All the tubes were forward of the sail and were fully enclosed, except when actually required to be launched. Most important of all, however, was that the new missiles could be launched while the submarine was submerged. Eleven Charlie Is were built and entered service between 1968 and 1972; all have now been paid off.

The follow-on was the Charlie II, which was longer and mounted a new and much improved missile, the SS-N-9 (NATO = Siren). Six were built between 1973 and 1980, all at the Gorky yard at Nizhny Novgorod.

DESIGN

The 'Charlie' class was the first Soviet design to be able to launch its SSMs without having to surface. Although similar in some respects to the 'Victor' class, visible differences include the bulge at the bow, the almost vertical drop of the forward end of the fin, a slightly lower after casing and a different arrangement of free-flood holes in the casing.

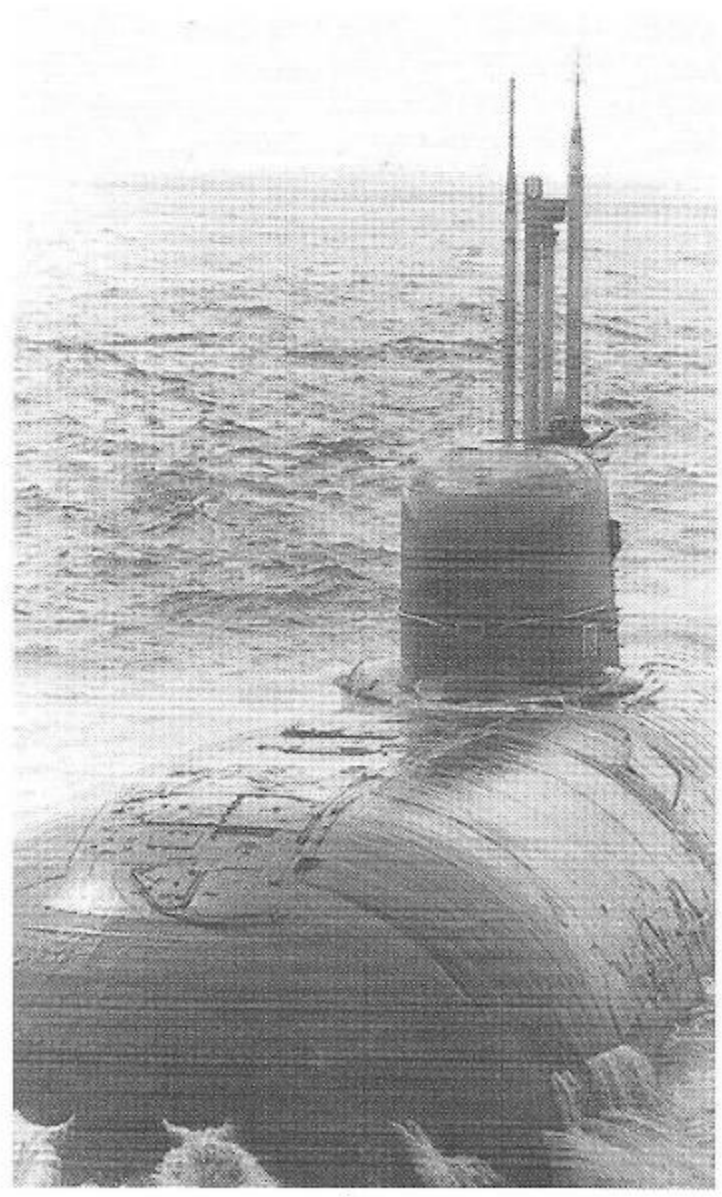
Unlike the 'Victor' class, the 'Charlie I' class had only one nuclear reactor of an 'improved' design, which resulted in a loss of speed of some 5 knots compared to the SSN. Curiously, however, it has recently been discovered that the Charlie II, which was long thought also to have only one reactor, does, in fact have two, although the reason for discarding the single reactor design is not yet known.

Some Charlie IIs have a raised platform around the forward part of the fin, together with a similar addition around the stern fin, which may be designed to smooth the flow of water in these areas.

Indian Navy
One 'Charlie I' class SSGN was leased to India in 1988 and operated as INS *Chakra* until 1991, when it was returned. The Russians allowed Indian officials to 'stand by' the submarine during its construction and also supplied detailed hull drawings, neither of which is banned by existing international treaties, but did not supply details of the propulsion plant, which is. Thus, although the design of the Indian SSN could be based on the Charlie I, the nuclear plant and its containment vessel will be designed entirely in India.

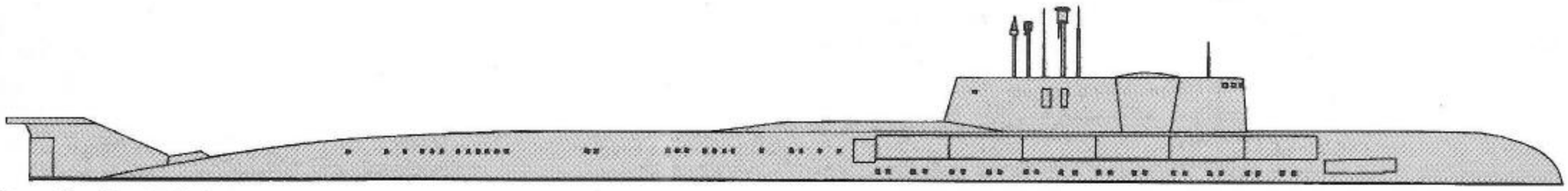
OPERATIONAL

The two remaining Charlie IIs are based in the Northern Fleet, but one of them is a trials submarine for the SS-CX-5 missile which is likely to be fitted in the 'Severodvinsk' class (Type 885). This new missile is the submarine version of the Nanuchka IV weapon and is believed to have a range of some 162 n miles (300 km).



Charlie II (US Navy)

OSCAR



Oscar (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia
Designation: *Podvodnaya Lodka Atomnaya Raketnaya Krylataya (PLARK)*

Class: OSCAR I (GRANIT) (TYPE 949)
OSCAR II (ANTYEY) (TYPE 949A)

Built:
Oscar I: 2
Oscar II: 12
Active:
Oscar I: 0
Oscar II: 12
Building:
Oscar I: 0
Oscar II: 1

In reserve:
Oscar I: 2
Oscar II: 0

Oscar I
Displacement:
surfaced: 12,600 t
submerged: 16,600 t

Dimensions
Length: 143 m (469.2 ft)
Beam: 18.2 m (59.7 ft)
Draught: 9 m (29.5 ft)

Speed, submerged: 30 kts
Diving depth: 300 m (1,000 ft)

Complement: 135

Oscar II
Displacement:
surfaced: 13,900 t
submerged: 18,300 t

Dimensions
Length: 154 m (505.2 ft)
Beam: 18.2 m (59.7 ft)
Draught: 9 m (29.5 ft)

Speed, submerged: 28 kts
Diving depth: 300 m (1,000 ft)

Complement: 135

SUBMARINES

Oscar I

ARKHANGELYSK (K 206)
Builder Severodvinsk Shipyard, Russia
Launched Apr 1980
Commissioned Nov 1980

MURMANSK (K 525)
Builder Severodvinsk Shipyard, Russia
Launched Dec 1982
Commissioned Jun 1983

Oscar II

KRASNODAR (K 148)
Builder Severodvinsk Shipyard, Russia
Launched Aug 1985
Commissioned Dec 1986

BELGOROD (K 132)
Builder Severodvinsk Shipyard, Russia
Launched Mar 1986
Commissioned Jan 1987

VERONESH (K 119)
Builder Severodvinsk Shipyard, Russia
Launched Dec 1987
Commissioned Dec 1988

CHELYABINSK (K 173)
Builder Severodvinsk Shipyard, Russia
Launched Jan 1989
Commissioned Dec 1989

SMOLENSK (K 410)
Builder Severodvinsk Shipyard, Russia
Launched Dec 1989
Commissioned Dec 1990

PEKOV (K 442)
Builder Severodvinsk Shipyard, Russia
Launched Jan 1990
Commissioned Jan 1991

KASATKA (K 456)
Launched Dec 1991
Commissioned Nov 1992

OREL (K 266)
Builder Severodvinsk Shipyard, Russia
Launched Jan 1992
Commissioned Jan 1993

OMSK (K 186)
Builder Severodvinsk Shipyard, Russia
Launched May 1993
Commissioned Dec 1993

KURSK (K 141)
Builder Severodvinsk Shipyard, Russia
Launched May 1994
Commissioned Oct 1994

TOMSK (K 512)
Builder Severodvinsk Shipyard, Russia
Launched May 1995
Commissioned May 1996

KK 530
Builder Severodvinsk Shipyard, Russia
Launched 1996
Commissioned 1997

Builder Severodvinsk Shipyard, Russia
Launched 1997
Commissioned 1998

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

SS-N-19 (NATO = Shipwreck)

24 SS-N-19 anti-ship missiles. SS-N-19 is essentially an improved version of SS-N-12, but with a lower flight profile to improve its chances of survival. The missile has a cylindrical body with pointed nose, two sharply sweptback wings and two sweptback tail fins, with a stabiliser on the underside of the missile. Some reports suggest a cold launch by means of a ram, but there are two solid fuel booster rockets which lift the missile in a ballistic trajectory until the turbojet takes over for the cruise phase.

The missile uses inertial guidance in cruise, with active radar terminal guidance, and mid-course guidance in over-the-horizon (OTH) engagements. In the submarine the missile tubes are in two rows either side of the hull and abreast the sail. The tubes are in pairs and are fixed at an angle of 40°, with a hinged 7 m (23 ft) long hatch protecting each pair. No reloads are carried. In contrast to previous long-range anti-ship missiles, there is no missile guidance radar such as Front Door and reports suggest that this task may be carried out by Tu-95 'Bear D' long-range, land-based reconnaissance aircraft, or by Ka-25 'Hormone C' or Ka-27 'Helix B' helicopters with Big Bulge I/J-band radar operating from a nearby surface ship. Alternatively, Radar Ocean Surveillance Satellites (RORSAT) could be used.

The submarine fire-control system is apparently based upon the Rim Hat mast which has a Snoop Pair radar/ESM/datalink complex with back to back antennas, one for radar and the other for ESM/datalink at the top of the mast. It is reported that this system provides course correction data to the missile, which, in turn, provides the launch platform with an Inverse Synthetic Aperture Radar Image, enabling it to make target selection. However, it seems more probable that the aircraft and the satellite feed target location data to the submarines and it is noteworthy that the Oscars carry 'Punch Bowl' satellite communications systems. Targets can also be acquired by submarine sensors, either radar or sonar, the bearing and range data then being fed into the missile guidance system.

When the missile achieves an altitude of 20,000 m (65,600 ft) it enters the cruise phase, until the active radar seeker acquires the target when the terminal phase begins. Some reports suggest the seeker has a 'home-on-jam' capability. The terminal phase is completed with a high-angle dive attack.

Specifications

Length: 10 m (32.80 ft)
Diameter: 85 cm (2.79 ft)
Wing span: 1.65 m (5.41 ft)
Weight: 3,250 kg (7,164 ft)
Speed: Mach 1.6 (some sources state Mach 2 or Mach 2.5)
Range: 11-296 n miles (20-550 km)

Guidance: Inertial with command update and active radar
Warhead: 750 kg (1,653 lb) high explosive, with impact and proximity fuzes. May also have nuclear and fuel-air explosive warheads

Manufacturer/Contractor
NPO Mashinostroyenia, Russia.

TUBES

Four 533 mm (21 in) tubes.
Two 650 mm (25.6 in) tubes.
Total weapon load, 24 weapons including tube-launched ASW missiles (but excluding the 24 SS-N-19).

TORPEDOES

Combination of 650 mm and 533 mm torpedoes.

SS-N-15 (NATO = Starfish)
SS-N-15 (Starfish) long-range anti-submarine weapon system is believed to be similar in general design and method of operation to the US Navy's now-discarded SUBROC. The Russian missile has a long, slim cylinder with small, retractable fins and a booster rocket at the end and carries either a Type 40 lightweight torpedo or a 200 kT nuclear depth charge (it should be noted, however, that, under current international agreements, nuclear warheads are not to be carried at sea; the capability, of course, remains).

SS-N-15 is associated with a low-frequency, bow-mounted, active/passive sonar system with 6 m diameter array (NATO = Shark Teeth). The weapon is loaded into a standard 533 mm torpedo tube and is then launched in the same way as a torpedo, travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere where it flies to the target area. It then ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern.

Specifications
SS-N-15
Length: 6.5 m (21.33 ft)
Diameter: 533 mm (21 in)
Wing span: n/k
Weight: 1,800 kg (3,968 lb)
Range: 24-27 n miles (45-50 km)
Speed: n/k
Guidance: Inertial
Payload: Nuclear; 200 kT or Type 40 torpedo

SS-N-16 (NATO = Stallion)
SS-N-16 is similar in concept to SS-N-15 but is a little larger and is launched from 650 mm tubes. It is associated with the Shark Gill bow-mounted sonar, which is integrated with a passive, towed array sonar. The weapon is loaded into a standard 650 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere, where the wings deploy and it flies to the target area. It then ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern.

Payload is usually an E45-75A lightweight torpedo with a range of 8.1 n miles (15 km) at 30 knots. The torpedo has both passive and active sonar sensors and a warhead of either 100 kg (220.5 lb) high explosives (SS-N-16A Veder) or a nuclear warhead of undetermined power (SS-N-16B Vodopod). (Note that under current international agreements, nuclear warheads would not be carried at sea, although the capability, of course, remains.)

Specifications
Length: 6.7 m (21.98 ft)
Diameter: 650 mm (25.6 in)
Span: n/k
Weight: 1,850 kg (4,078 lb)
Range: 54 n miles (100 km)
Speed: n/k
Guidance: Inertial
Payload:
SS-N-16A: Type 40 torpedo; active/passive homing to 8.1 n mile (15 km) at 45 kts; warhead 60 kg (132 lb)
SS-N-16B: 200 kT nuclear warhead

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Bald Head
Bald Head is a mast-mounted ESM system at the top of which is a cylindrical radome with 32 directional ports arranged in four tiers, each covering a specific frequency band: D (1-2 GHz), E/F (2-4 GHz), G/H (4-8 GHz) and I/J (8-20 GHz).

Rim Hat
Rim Hat radar warning receiver consists of a number of intercept antennas mounted in a circle at the base of the Snoop Pair motor drive unit.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS

Pert Spring Satcom.
ELF/VLF communications buoy.

WEAPONS CONTROL

Punch Bowl
Punch Bowl is a satellite communications receiver used for third party targeting.

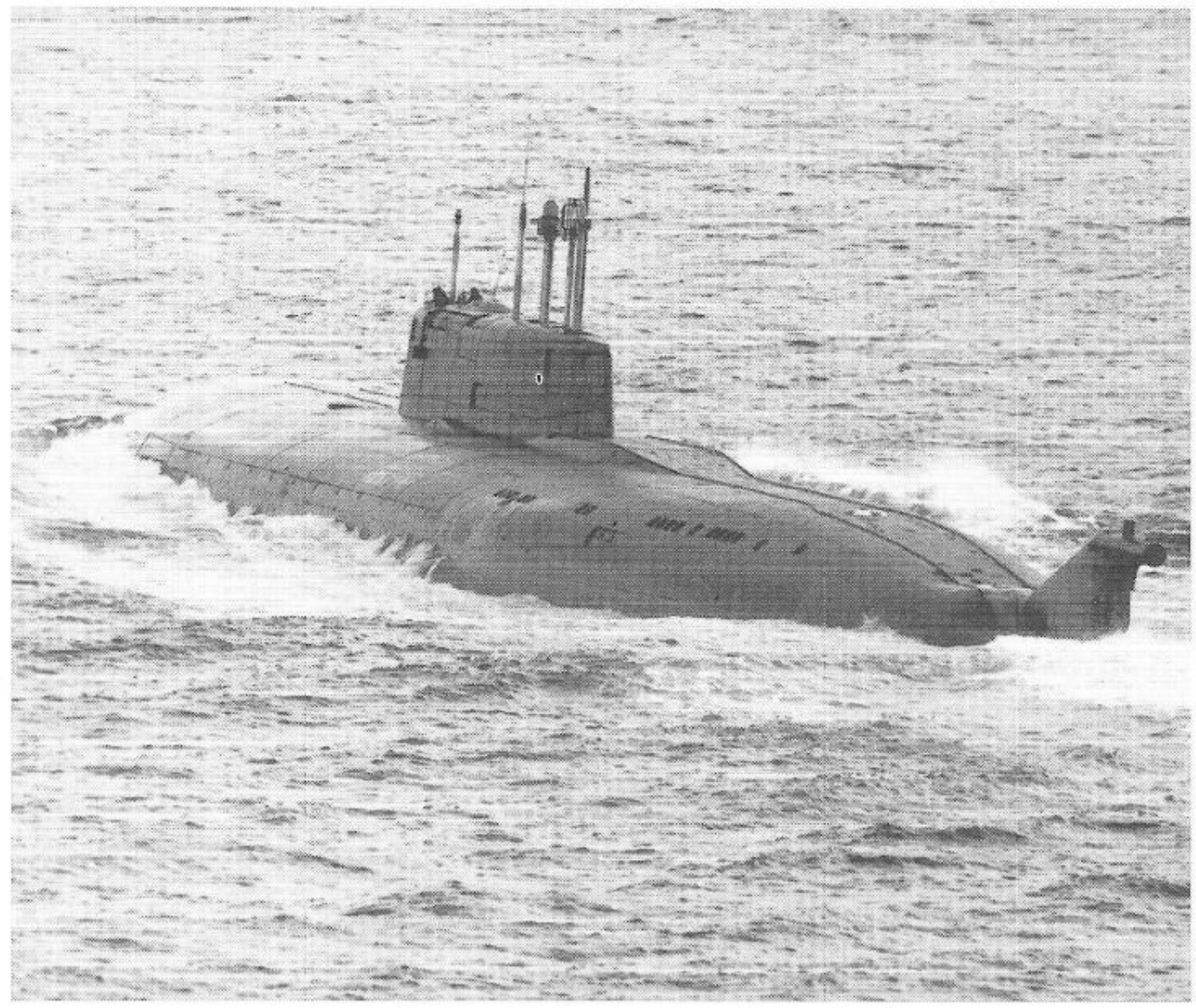
RADAR

The Snoop Pair radar/ESM/ datalink complex has back to back antennas, one for an I-band surface search radar, the other for ESM/datalink at the top of the mast.

SONARS

Shark Gill
Shark Gill is a hull-mounted, passive/active search and attack sonar, operating at low and medium frequencies.

Mouse Roar
Mouse Roar is a hull-mounted, high-frequency, active attack sonar.



Oscar II. Note the tube on top pf the rudder for the Pelamida towed array

PROPULSION

Specifications
System: Nuclear
Reactors: 2 VM-5 pressurised water reactors (PWR)
Power output: 190 MW
Turbines: 2 GT3A steam turbines
Power output: 72 MW (98,000 hp(m))
Shafts: 2
Spinners: 2

FURTHER INFORMATION

PROGRAMME

These very large submarines are probably the final example of the Russian Navy's predilection for specialised cruise missile launch platforms, and are the successors to the 'Echo-II' class. The first Oscar I was laid down at Severodvinsk in 1978, and the second a year later.

The third of class became the first Oscar II, with a hull lengthened by 11 m (36.1 ft) and an increased displacement of 1,400 tons. Oscar IIs are still being built at a rate of one a year at Severodvinsk.

DESIGN

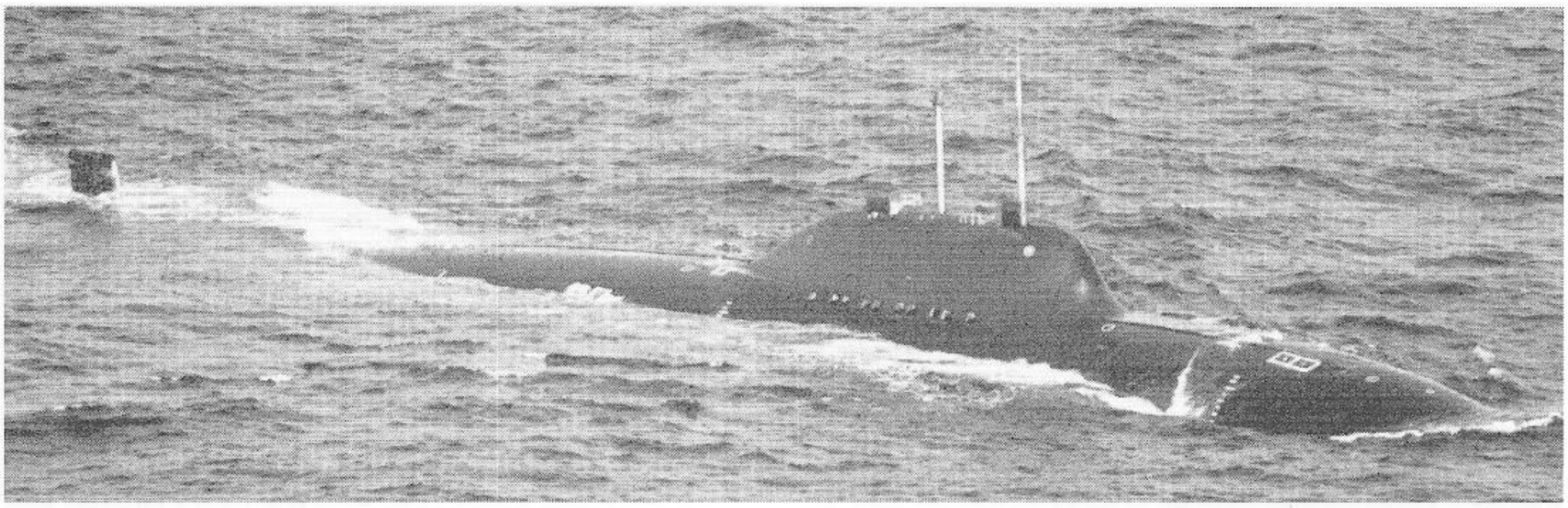
The missile tubes are in two banks of 12 running down either side of and outside the 8.5 m (27.89 ft) diameter pressure hull. This results in a gap of some 3 m (9.84 ft) between the outer and inner hulls, and in a very large beam. The missile tubes are inclined at 40°, with one hatch covering each pair. The reason for the longer Oscar II is still not apparent, but may have been the result of some deficiency found in first of class trials, which could not be corrected in time to change hull number two. Alternatively it could be related to the plan to install SS-N-24 missiles in due course.

All but the first of class have a tube on the rudder fin as in the Delta IV, which is used for dispensing a thin line towed sonar array.

OPERATIONAL

The two Oscar Is based in the Northern Fleet were non-operational in 1995 and may be scrapped in 1996/97. The Oscar IIs are divided, with five in the Pacific Fleet and the remainder with the Northern Fleet except for the last of class, which is still fitting out.

ALFA



The last of the 'Alfa' class is used for occasional trials, although it is still classified as an operational SSN

GENERAL SPECIFICATIONS

Country: Russia
Designation: *Podvodnaya Lodka Atomnaya (PLA)*

Class: ALFA (TYPE 705SMT)

Built: 7
Active: 1
Building: 0

Displacement:
surfaced: 2,700 t
submerged: 3,600 t

Dimensions
Length: 81.5 m oa (267.4 ft); 75 m wl (246.1 ft)
Beam: 9.5 m (31.2 ft)
Draught: 7.5 m (24.6 ft)

Speed, submerged: 40 kts
Diving depth: 700 m (2,500 ft)

Complement: 40

WEAPONS SYSTEMS

TUBES

Six 533 mm (21 in) tubes.

TORPEDOES

Combination of 533 mm (21 in) torpedoes.
Total weapons, 20 torpedoes.

MINES

Up to 40 in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Bald head
Bald Head is a mast with a cylindrical radome at the top with 32 directional ports arranged in four tiers, each covering a specific frequency band: D (1-2 GHz), E/F (2-4 GHz), G/H (4-8 GHz) and I/J (8-20 GHz).

Brick Spit/Brick Pulp
Brick Spit and Brick Pulp are ESM systems, presumably used for surveillance and threat warning.

Park Lamp
Park Lamp is a mast-mounted VLF/LF receiving antenna, consisting of two open loops at right angles to each other.

COMMAND AND CONTROL

RADAR

Snoop Pair
Snoop Pair radar/ESM/datalink complex with back to back antennas, one for an I-band surface search radar and the other at the top of the mast for ESM/datalink.

SONARS

Shark Gill
Shark Gill is a hull-mounted, passive/active search and attack sonar, operating at low/medium frequencies.

Mouse Roar
Mouse Roar is a hull-mounted, active attack sonar. It operates at high frequencies.

NAVIGATION

SINS
Satnav
Loran
Omega

PROPULSION

Specifications
System: Nuclear
Reactor: 1 BM-40A liquid-metal reactor (LMR)

Power output: 170 MW
Turbo-alternators: 2
Power output: 37 MW (50,000 hp(m))

Shafts: 1
Spinners: 2 (on after plane guards)

FURTHER INFORMATION

PROGRAMME

The first of this class was laid down in mid-1960s and completed in 1970 at Sudomekh, Leningrad. The building time was very long in comparison with normal programmes and it seems most likely that this was a prototype, which was scrapped in 1974. Six more were then built between 1979 and 1981, three each at Sudomekh and Severodvinsk, probably to an amended design which incorporated the lessons learnt from the first of class.

DESIGN

The relatively short overall length combined with the high speed indicate considerable progress in hydrodynamic design and laminar flow techniques. The great diving depth is the result of using titanium alloy for the hull, which also results in a much reduced magnetic signature. The sound profile of this class is, however, high, particularly at high speed although they are much quieter when travelling slowly.

The crew is 40, although some sources suggest as few as 29, and most indicate that all are officers. The small complement indicates a high level of automation, while, if the all-officer reports are correct, this suggests some very special requirements.

The lead-bismuth liquid-metal reactors provided extremely high-power density and enabled this class to travel at well over 40 knots submerged. The Soviet Navy deliberately provoked alarm in the West by running the first of class under a convoy, taking part in a NATO exercise in the late 1970s, at a speed in excess of 40 knots and at considerable depth. The surface warships were well able to track the interloper's progress but knew that in war they would have no means whatsoever of counteracting it.

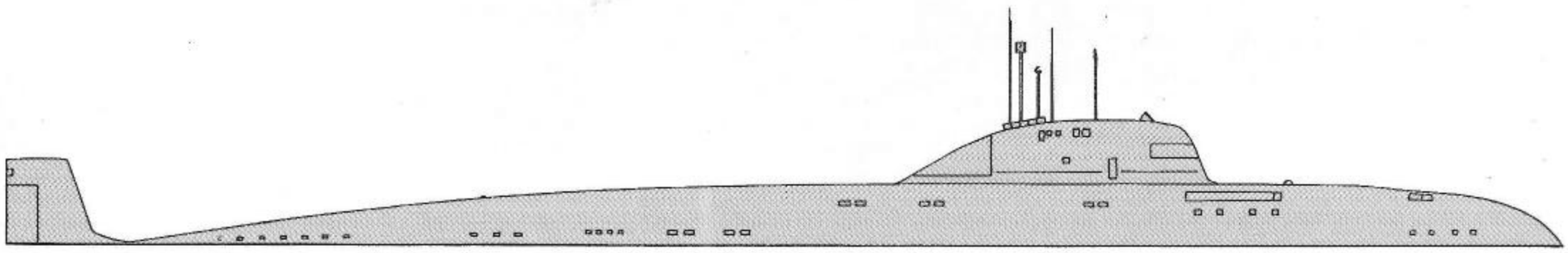
The hull is constructed of titanium, a material which combines lightness with great strength. Unfortunately, it is also very difficult to work and even the Russian expertise in metallurgy did not enable them to produce more than a few of these submarines, and very slowly at that.

OPERATIONAL

The one surviving 'Alfa' class boat was in refit for no less than five years, returning to service as a trials boat with a new propulsion system in late 1989. Although used for trials, this ship is still classified as an operational SSN and is based in the Northern Fleet.

Of the others, one was scrapped in 1988 and the rest of the class were defuelled in 1992/93 and are being scrapped.

VICTOR I



Victor I (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia
Designation: *Podvodnaya Lodka Atomnaya (PLA)*

Class: VICTOR I (KEFAL I) (TYPE 671T)

Built: 16
Active: 2
Building: 0

Displacement:
surfaced: 4,400 t
submerged: 5,300 t

Dimensions
Length: 94 m oa (308.4 ft); 86 m wl (282.2 ft)
Beam: 10.5 m (34.4 ft)
Draught: 7.3 m (24 ft)

Speed, submerged: 32 kts
Diving depth: 300 m (1,050 ft) approx

Complement: 70 (17 officers)

WEAPONS SYSTEMS

TUBES

Six 533 mm (21 in) tubes.
Total weapons carried, 24.

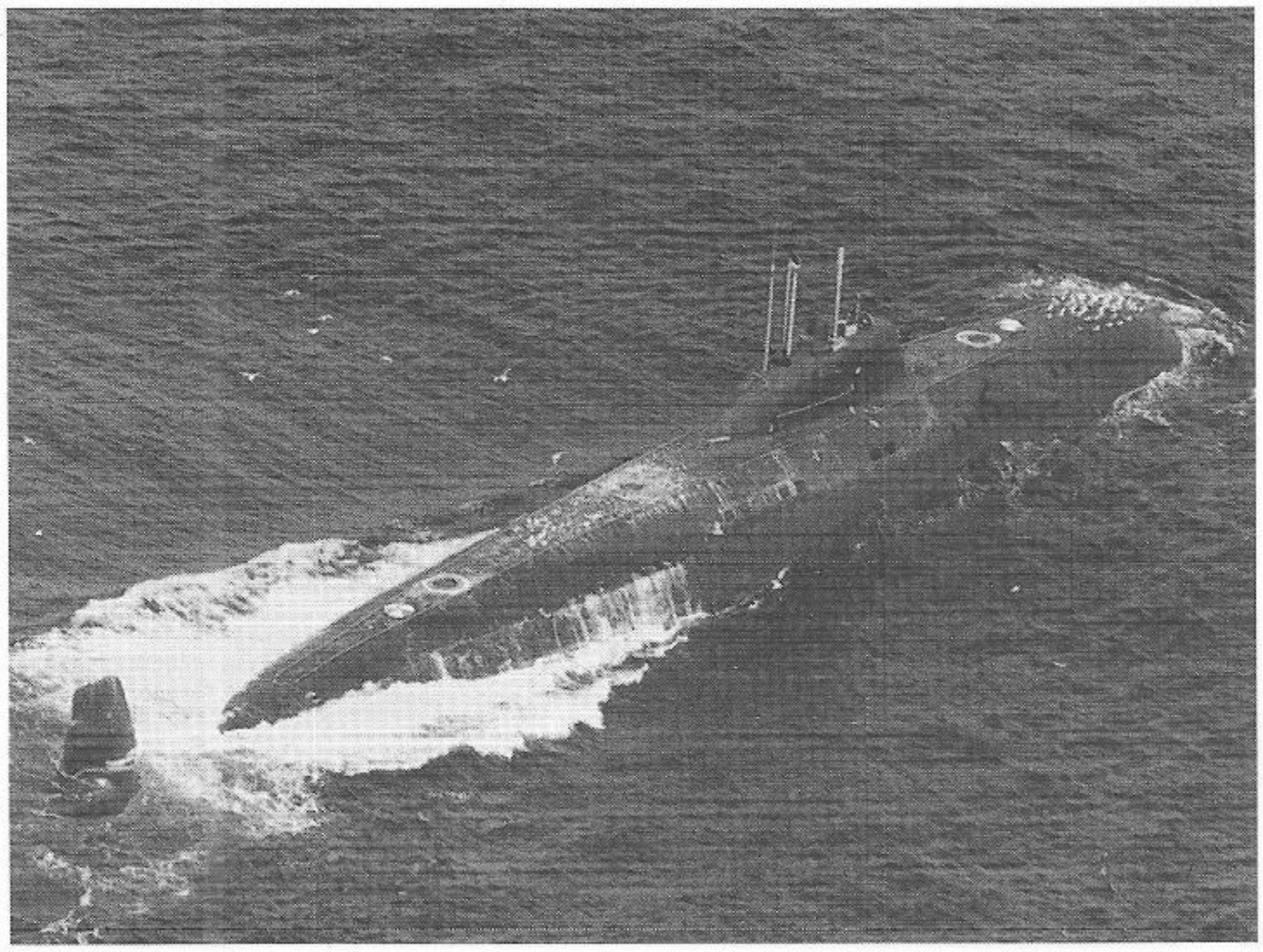
TORPEDOES

Type 53-65.

Specifications
Length: 7.8 m (25.60 ft)
Weight (dry): n/k
Range: 13 n miles (24 km)
Max speed: 55 kts
Warhead: 400 kg (881.8 lb) or low-yield nuclear

MINES

In lieu of torpedoes.



Two Victor Is remain in service

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Brick Group
Brick Group is a radar warning set.

Park Lamp
Park Lamp is a low-frequency communications antenna.

COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Tray
Snoop Tray is an I-band surface search antenna.

SONARS

Shark Teeth
Shark teeth is a hull-mounted, passive/active search and attack, low- to medium-frequency sonar.

Mouse Roar
Mouse Roar is a hull-mounted, active attack sonar, operating at high frequency.

PROPULSION

Specifications
System: Nuclear
Reactors: 2 VM-4P pressurised water reactors (PWR)

Power output: 150 MW
Steam turbines: 2
Power output: 22 MW (30,000 hp(m))

Shafts: 1
Spinners: 2

FURTHER INFORMATION

PROGRAMME

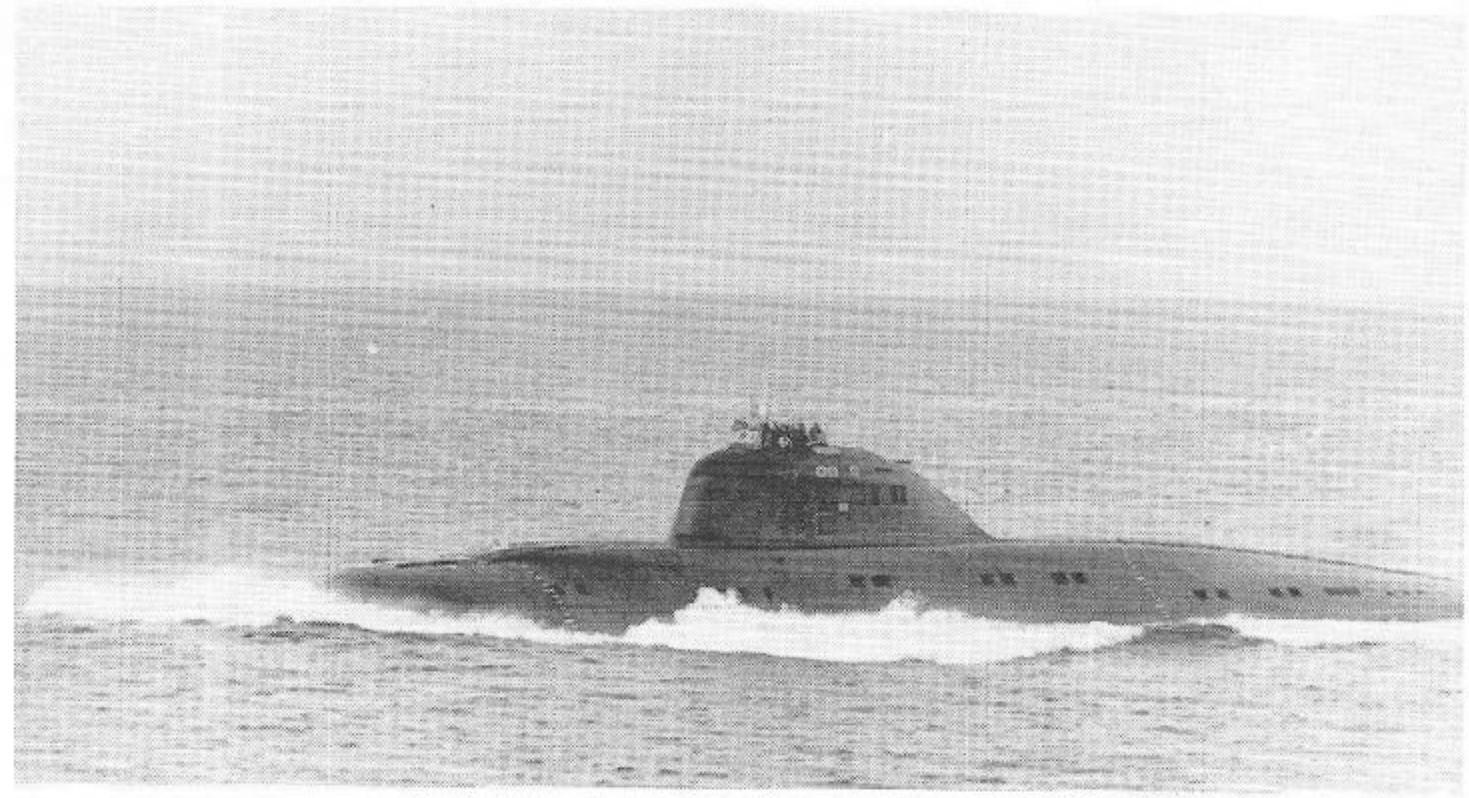
The first Victor was laid down in 1965 and entered service in 1967, following which the class was built at the Admiralty Yard, Leningrad at a rate of two per year until 1974, when it was succeeded on the ways by the 'Victor II' class.

DESIGN

This was the first Soviet submarine with a 'body-of-revolution' hull, similar to, but by no means based on, the US Navy's Albacore hull form. It also had two nuclear reactors, which are positioned side by side. Like all Russian submarines it is of double-hulled form but, unlike the contemporary Charlie it has two reactors giving an enhanced speed.

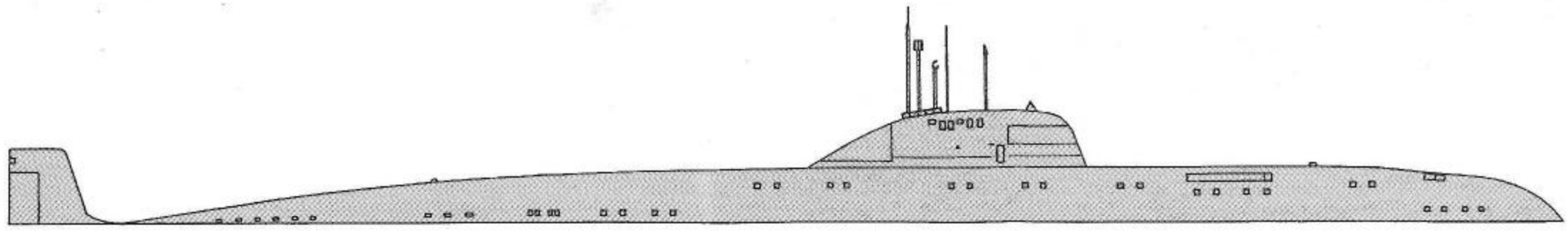
OPERATIONAL

The Victor Is are becoming unreliable and of the original 16 units 14 have been withdrawn from service, one as a result of a reactor refuelling accident in August 1985. The two survivors are both in the Northern Fleet and will pay off soon. These submarines originally carried SS-N-15 tube-launched missiles but these appear to have been withdrawn leaving these two boats armed only with somewhat elderly torpedoes.



Victor I under way during the heyday of the class when 16 were in service (US Navy)

VICTOR II



Victor II (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia
Designation: *Podvodnaya Lodka Atomnaya (PLA)*

Class: VICTOR II (KEFAL II) (TYPE 671RT)

Built: 7
Active: 3
Building: 0

Displacement:
surfaced: 4,700 t
submerged: 5,800 t

Dimensions
Length: 103 m oa (337.9 ft); 96 m wl (315.0 ft)
Beam: 10.6 m (34.8 ft)
Draught: 7.4 m (24.3 ft)

Speed, submerged: 30 kts
Diving depth: 320 m (1,050 ft) approx

Complement: 70 (17 officers)

WEAPONS SYSTEMS

TUBES

Two 533 mm (21 in) tubes.
Four 650 mm (25.6 in) tubes.
Total weapon load, 24.

TORPEDOES

Combination of 533 mm and 650 mm torpedoes.

SS-N-15 (NATO = Starfish)

SS-N-15 (Starfish) long-range anti-submarine weapon system is believed to be similar in shape to SUBROC, having a long, slim cylinder with small, retractable fins and a booster rocket at the end. SS-N-15 is associated with a low-frequency, bow-mounted, active/passive sonar system with 6 m (19.7 ft) diameter array (NATO = Shark Teeth). The weapon is loaded into a standard 533 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-15 payload is either a 200 kT nuclear depth charge or a Type 40 lightweight torpedo and it should be noted that, under current international agreements, nuclear warheads would not be carried at sea; the capability, however, remains.

Specifications
Length: 6.5 m (21.33 ft)
Diameter: 533 mm (21 in)
Wing span: n/k
Weight: 1,800 kg (3,968 lb)
Range: 24-27 n miles (45-50 km)
Speed: n/k
Guidance: Inertial

SS-N-16 (NATO = Stallion)

SS-N-16 (NATO = Stallion) is a 650 mm tube-launched missile associated with the Shark Gill sonar system, which is integrated with a passive, towed array sonar. The weapon is loaded into a standard 650 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-16 payload is usually an E45-75A lightweight torpedo with a range of 8.1 n miles (15 km) at 30 knots. The torpedo has both passive and active sonar sensors and a warhead of either 100 kg (some sources say 90 kg) high explosives (SS-N-16A Veder) or a nuclear warhead of undetermined power (SS-N-16B Vodopod), although under current international agreements, nuclear warheads would not be carried at sea, but the capability, of course, remains.

Specifications
Length: 6.7 m (21.98 ft)
Diameter: 650 mm (25.61 in)
Wing span: n/k
Weight: 1,850 kg (4,078 lb)
Range: 50 n miles (92 km)
Speed: n/k
Guidance: Inertial

MINES

Up to 36 in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Brick Spit/Brick Pulp

Brick Spit and Brick Pulp are ESM systems, presumably used for surveillance and threat warning.

Park Lamp

Park Lamp is a mast-mounted VLF/LF receiving antenna, consisting of two open loops at right angles to each other.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS

VLF communications buoy.
VHF and UHF aerials.
Kremmny 2 IFF.

RADAR

Snoop Tray

Snoop Tray is a mast-mounted, I-band, surface search radar antenna.

SONARS

Shark Teeth

Shark Teeth is a hull-mounted, passive/active search and attack sonar, operating at low and medium frequencies.

Mouse Roar

Mouse Roar is a hull-mounted, high-frequency, active, attack sonar.

NAVIGATION

SINS
Satnav.

PROPULSION

Specifications
System: Nuclear
Reactors: 2 VM-4 pressurised water reactors (PWR); 130 MW

Steam turbines: 2–22 MW (30,000 hp(m))
Shafts: 1
Spinners: 2

FURTHER INFORMATION

PROGRAMME

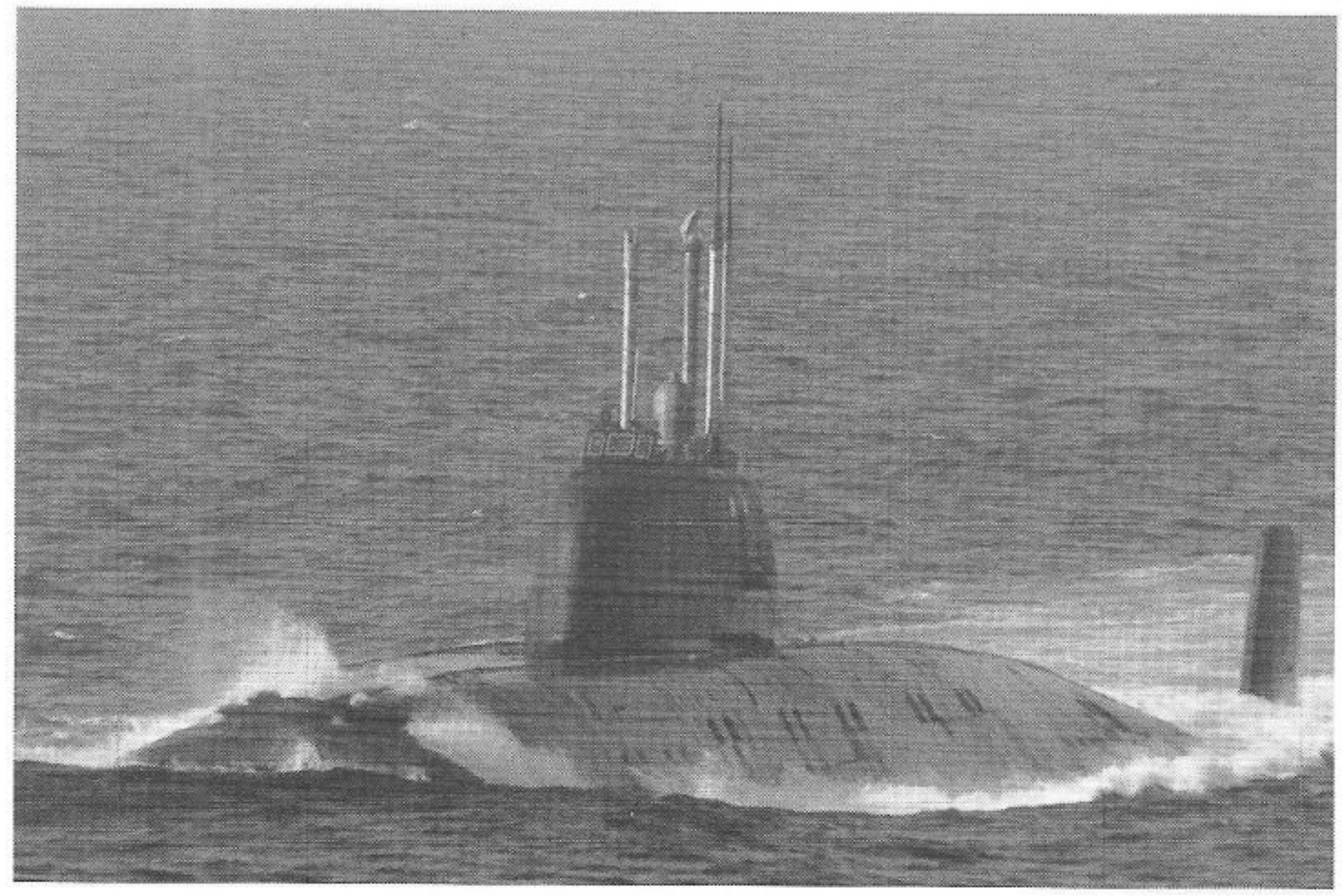
The first Victor II was commissioned in 1972 and the class was built fairly rapidly, with the seventh and last unit being commissioned in 1978. They were built at either the Admiralty Yard, Leningrad (now St Petersburg) or at Gorky.

DESIGN

The essential differences between Victor II and its predecessor Victor I is that the new class is some 9 m (29.52 ft) longer – and also some 2 knots slower. The extra length was needed in order to accommodate the then new 650 mm (26.5 in) tubes and to provide the larger storage space required by the SS-N-16 tube-launched missiles.

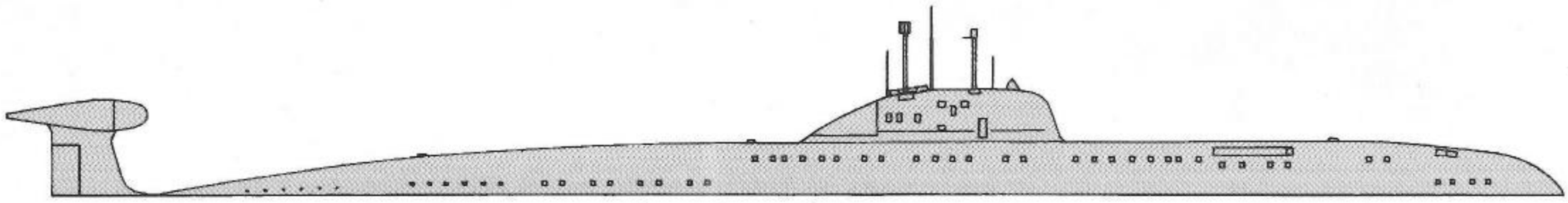
OPERATIONAL

The three surviving Victor IIs are in the Northern Fleet, but despite expectations for some years that they were about be paid off they appear to remain in service.



Victor II

VICTOR III



Victor III (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia

Class: VICTOR III (SHUKA) (TYPE 671RTM)

Built: 26
Active: 26
Building: 0

Displacement:
surfaced: 4,850 t
submerged: 6,300 t

Dimensions
Length: 107 m (351.1 ft)
Beam: 10.6 m (34.8 ft)
Draught: 7.4 m (24.3 ft)

Speed, submerged: 30 kts
Diving depth: 320 m (1,050 ft)

Complement: 70 (17 officers)

SUBMARINES

Built at Admiralty Yard, Leningrad and serving in the Northern fleet:

K 138	K 247	K 264	K 355	K 448	K 502
K 524	K 255	K 292	K 299	K 358	K 388
K 414	K 492	K 507	K 527		

Built at Komsomolsk and serving in the Far East Fleet:

K 242	K 254	K 298	K 305	K 360	K 412
K 218	K 244	K 251	K 324		

WEAPONS SYSTEMS

TUBES

Four 533 mm (21 in) tubes.
Two 650 mm (25.6 in) tubes (liners can be used to launch) 533 mm (21 in) torpedoes.
Number of weapons, 24.

TORPEDOES

Combination of 533 mm and 650 mm torpedoes.

SS-N-21 (NATO = Sampson)

SS-N-21 (NATO = Sampson) is a land-attack missile launched from 533 mm (21 in) torpedo tubes and is the Russian equivalent to the US Tomahawk. Like that American missile, the SS-N-21 flies at low altitude (approximately 200 m (656 ft)) using a terrain-following guidance system. SS-N-21 has a range of some 1,620 n miles (3,000 km) and a cep of 150 m (492 ft), making it a formidable land attack weapon, although it has yet to demonstrate its potential as dramatically as did Tomahawk missiles in the Gulf War. There are two other versions of this missile: a surface ship-launched missile — SSC-4, and an air-launched missile — AS-15 Kent.

Specifications
Length: 8.09 m (26.54 ft)
Diameter: 0.51 m (20 in)
Wing span: 2.5 m (8.2 ft)
Weight: 1,700 kg (3,748 lb)
Speed: Mach 0.7
Altitude: Approx 200 m (656 ft)
Range: 1,620 n miles (3,000 km)
Guidance: Inertial/terrain-following
Warhead: Nuclear 200 kT

Accuracy—circular error probable (cep): 0.08 n miles (150 m)

SS-N-15 (NATO = Starfish)

SS-N-15 (Starfish) long-range anti-submarine weapon system is believed to be similar in shape to SUBROC, having a long, slim cylinder with small, retractable fins and a booster rocket at the end. SS-N-15 is associated with a low-frequency, bow-mounted, active/passive sonar system with 6 m (19.75 ft) diameter array (NATO = Shark Teeth). The weapon is loaded into a standard 533 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-15 payload is either a 200 kT nuclear depth charge or a Type 40 lightweight torpedo and it should be noted that, under current international agreements, nuclear warheads would not be carried at sea; the capability, however, remains.

Specifications
Length: 6.5 m (21.33 ft)
Diameter: 533 mm (21 in)
Wing span: n/k
Weight: 1,800 kg (3,968 lb)
Range: 24-27 n miles (45-50 km)
Speed: n/k
Guidance: Inertial

SS-N-16 (NATO = Stallion)

SS-N-16 (NATO = Stallion) is a 650 mm tube-launched missile associated with the Shark Gill sonar system, which is integrated with a passive, towed array sonar. The weapon is loaded into a standard 650 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-16 payload is usually an E45-75A lightweight torpedo with a range of 8.1 n miles (15 km) at 30 knots. The torpedo has both passive and active sonar sensors and a warhead of either 100 kg (some sources say 90 kg) high explosives (SS-N-16A Veder) or a nuclear warhead of undetermined power (SS-N-16B Vodopod), although under current international agreements, nuclear warheads would not be carried at sea, but the capability, of course, remains.

Specifications
Length: 6.7 m (21.98 ft)
Diameter: 650 mm (25.61 in)
Wing span: n/k
Weight: 1,850 kg (4,078 lb)
Range: 50 n miles (92 km)
Speed: n/k
Guidance: Inertial

MINES

Up to 36 mines can be carried in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Brick Spit/Brick Pulp

Brick Spit and Brick Pulp are ESM systems, presumably used for surveillance and threat warning.

Park Lamp

Park Lamp is a mast-mounted VLF/LF receiving antenna, consisting of two open loops at right angles to each other.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS

VLF communications buoy.
VHF/UHF aerials.
Pert Spring Satcom.
Kremmny 2 IFF.

RADAR

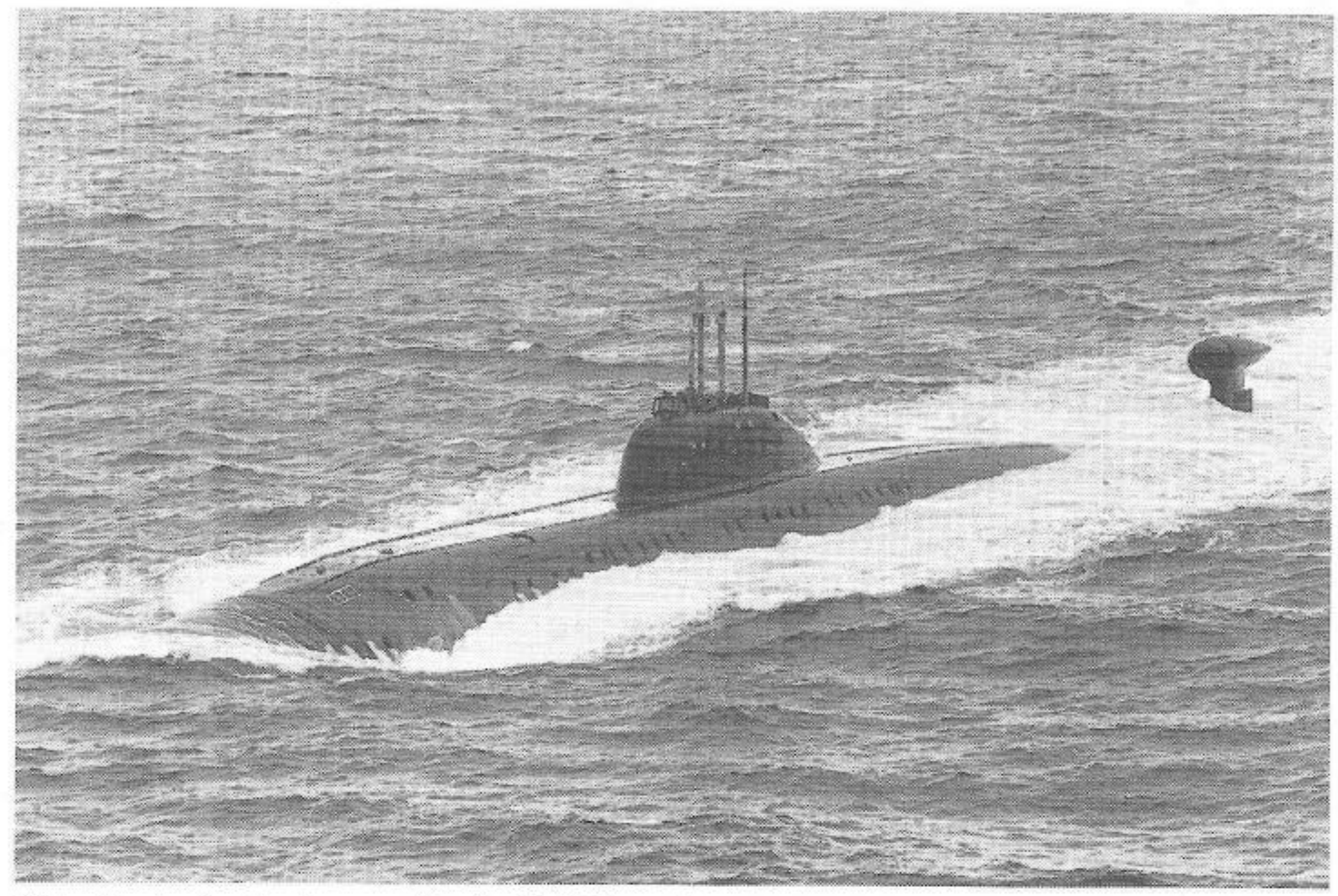
Snoop Tray
Snoop Tray is a mast-mounted, I-band, surface search radar antenna.

SONARS

Shark Gill
Shark Gill is a hull-mounted, passive or active search and attack sonar, operating at low/medium frequencies.

Mouse Roar
Mouse Roar is a hull-mounted, high-frequency, active attack sonar.

Skat 3
Skat 3 is a thin-line, towed array.



Victor III, showing the large pod for the Skat 3 towed array

NAVIGATION

SINS and Satnav.

PROPULSION

Specifications
System: Nuclear
Reactors: 2 VM-4 pressurised water reactors (PWR)

Power output: 150 MW
Steam turbines: 2
Power output: 22.7 MW (31,000 hp(m))

Shafts: 1
Spinners: 2

FURTHER INFORMATION

PROGRAMME

An improvement on Victor II, the first of class being completed at Komsomolsk in 1978. With construction also being carried out at Admiralty Yard, Leningrad, there was a very rapid building programme up to the end of 1984. Construction then continued only at Leningrad and at a rate of about one per year which terminated in 1991. The last of the class completed sea trials in October 1992. It is of interest that construction of Victor III continued for some years after the introduction of the 'Sierra' and 'Akula' classes.

DESIGN

The Victor III is 13.2 m (43.3 ft) longer than Victor II. The streamlined pod on the stern fin is a towed sonar array dispenser. Water environment sensors are being mounted at the front of the fin and on the forward casing as in the 'Akula II' and 'Sierra' classes. One of the class has the trials SS-N-21 SLCM mounted on the forward casing and is sometimes known as the Victor IV (Type 671 RTMK).

Incremental improvements were made to the design and the last nine of the class are reported as being quieter than the others. It is assumed that these are the 'Improved Victor IIIs' shown on the US DoD table comparing US and Russian SSNs, which are shown as being at the upper limits of the USN 'Los Angeles' (SSN-688) class.

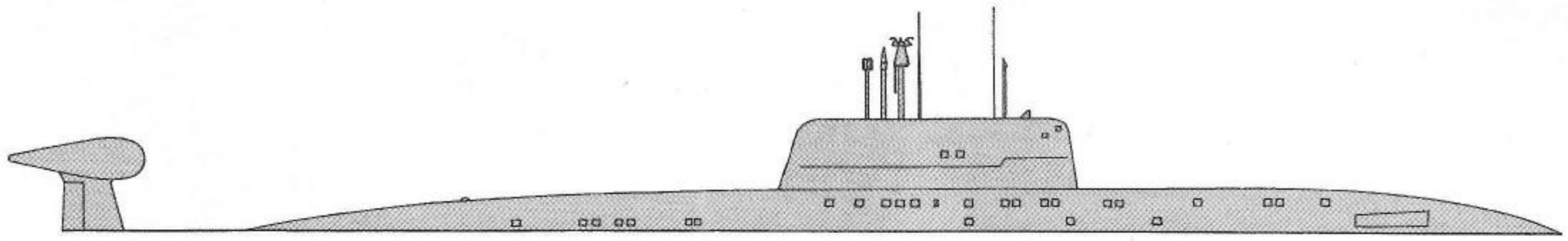
The early Victor IIIs have a seven-bladed propeller, but some Victor IIs and most Victor IIIs have an unusual propeller which consists of two, tandem, four-blade units mounted at 22.5° to each other on the same shaft. It is assumed that this offers some acoustic advantage, although it has not been repeated on any other Russian submarine.

OPERATIONAL

Ten are based in the Pacific and 16 in the Northern Fleet.

Victor III with numerous anechoic tiles missing (US DoD)

SIERRA I



Sierra I (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia

Class: SIERRA I (BARACUDA I) (TYPE 945A)

Built: 2
Active: 2 (may be in reserve)
Building: 0

Displacement:
surfaced: 7,000 t
submerged: 7,900 t

Dimensions
Length: 107 m (351 ft)
Beam: 12.5 m (41 ft)
Draught: 8.8 m (28.9 ft)

Speed, kts: 34 dived; 18 surfaced
Diving depth: 650 m (2,100 ft)

Complement: 72

SUBMARINES

BARACUDA	
Builder	Gorky Shipyard/ Severodvinsk Shipyard, Russia
Laid down	May 1982
Launched	Aug 1983
Commissioned	Aug 1984

KONDOR	
Builder	Gorky Shipyard/ Severodvinsk Shipyard, Russia
Laid down	Aug 1983
Launched	Jul 1986
Commissioned	Sep 1987

WEAPONS SYSTEMS

TUBES

Eight 650 mm (25.6 in). Liners are used to accommodate 533 mm (21 in) weapons.
Total weapon load, 40.

TORPEDOES

SS-N-21 (NATO = Sampson)

SS-N-21 (NATO = Sampson) is a land attack missile launched from 533 mm (21 in) torpedo tubes and is the Russian equivalent to the US Tomahawk. Like that American missile, the SS-N-21 flies at low altitude (approximately 200 m (656 ft)) using a terrain-following guidance system. SS-N-21 has a range of some 1,620 n miles (3,000 km) and a cep of 150 m (492 ft), making it a formidable land attack weapon, although it has yet to demonstrate its potential as dramatically as did Tomahawk missiles in the Gulf War. There are two other versions of this missile: a surface ship-launched missile — SSC-4, and an air-launched missile — AS-15 Kent.

Specifications
Length: 8.09 m (26.54 ft)
Diameter: 0.51 m (20 in)
Wing span: 2.5 m (8.2 ft)
Weight: 1,700 kg (3,748 lb)
Speed: Mach 0.7
Altitude: Approx 200 m (656 ft)
Range: 1,620 n miles (3,000 km)
Guidance: Inertial/terrain-following
Warhead: Nuclear 200 kT
Accuracy — circular error probable (cep): 0.08 n miles (150 m)

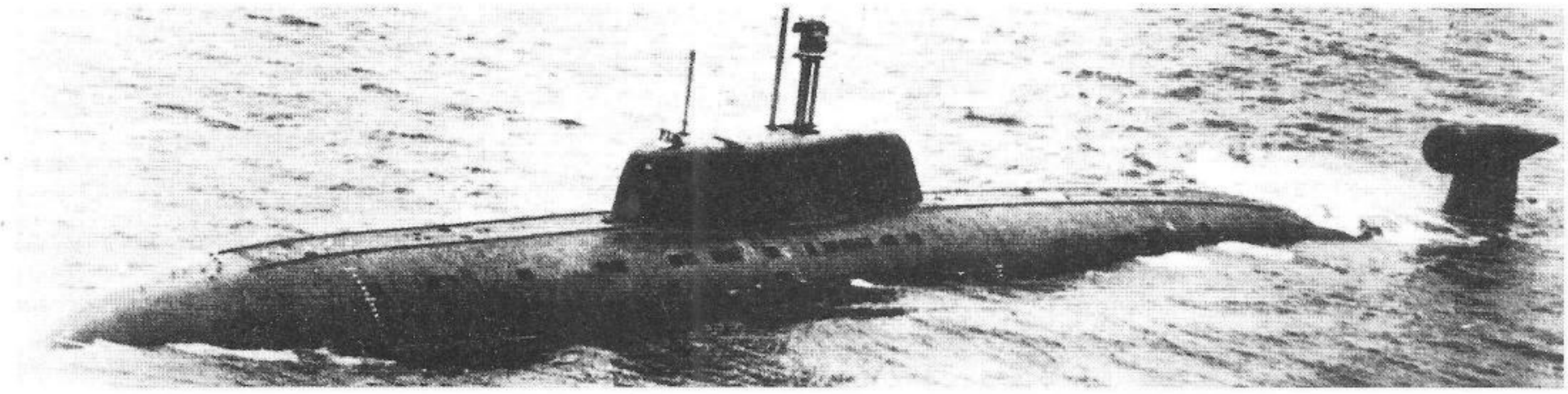
SS-N-15 (NATO = Starfish)

SS-N-15 (Starfish) long-range anti-submarine weapon system is believed to be similar in shape to SUBROC, having a long, slim cylinder with small, retractable fins and a booster rocket at the end. SS-N-15 is associated with a low-frequency, bow-mounted, active/passive sonar system with 6 m (19.7 ft) diameter array (NATO = Shark Teeth). The weapon is loaded into a standard 533 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-15 payload is either a 200 kT nuclear depth charge or a Type 40 lightweight torpedo and it should be noted that, under current international agreements, nuclear warheads would not be carried at sea; the capability, however, remains.

Specifications
Length: 6.5 m (21.33 ft)
Diameter: 533 mm (21 in)
Wing span: n/k
Weight: 1,800 kg (3,968 lb)
Range: 24-27 n miles (45-50 km)
Speed: n/k
Guidance: Inertial

SS-N-16 (NATO = Stallion)

SS-N-16 (NATO = Stallion) is a 650 mm tube-launched missile associated with the Shark Gill sonar system, which is integrated with a passive, towed array sonar. The weapon is loaded into a standard 650 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-16 payload is usually an E45-75A lightweight torpedo with a range of 8.1 n miles (15 km) at 30 knots. The torpedo has both passive and active sonar sensors and a warhead of either 100 kg (some sources say 90 kg) high explosives (SS-N-16A Veder) or a nuclear warhead of undetermined power (SS-N-16B Vodopod), although under current international



Baracuda *is one of only two 'Sierra I' class SSNs to be built*

agreements, nuclear warheads would not be carried at sea, but the capability, of course, remains.

Specifications

Length: 6.7 m (21.98 ft)
Diameter: 650 mm (25.61 in)
Wing span: n/k
Weight: 1,850 kg (4,078 lb)
Range: 50 n miles (92 km)
Speed: n/k
Guidance: Inertial

MINES

Maximum of 60 tube-launched mines in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Rim Hat
Rim Hat radar warning receiver consists of a number of intercept antennas mounted in a circle at the base of the Snoop Pair motor drive unit.

Park Lamp
Park Lamp is a mast-mounted VLF/LF receiving antenna, consisting of two open loops at right angles to each other.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS

Pert Spring Satcom.

RADAR

Snoop Pair
Snoop Pair is a radar/ESM/datalink complex with back to back antennas, one for an I-band surface search radar and the other for ESM/datalink at the top of the mast.

SONARS

Shark Gill
Shark Gill is a hull-mounted, passive/active search and attack sonar, operating at low/medium frequency.

Mouse Roar
Mouse Roar is a hull-mounted, active attack, high-frequency sonar.

PROPULSION

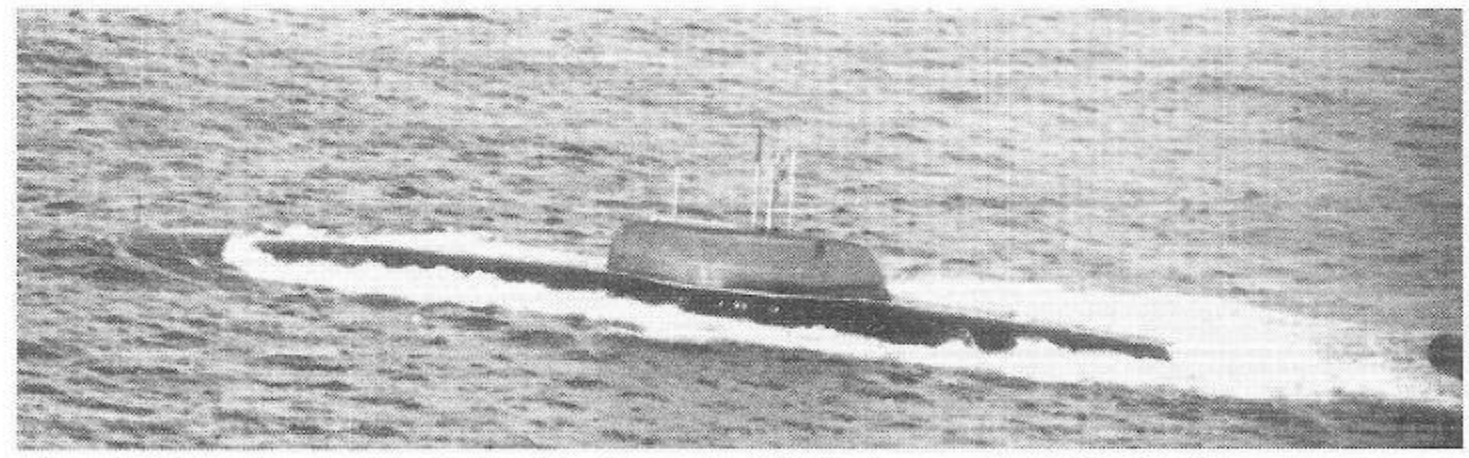
Specifications

System: Nuclear
Reactors: 1 VM-5 pressurised water reactor (PWR); 190 MW
Steam turbines: 2 GT3A; 70 MW (95,000 hp(m))
Shafts: 1
Spinners: 2

FURTHER INFORMATION

PROGRAMME

The first Sierra I was launched in 1983, commenced trials in late 1984 and was followed by the second and last boat which was commissioned in September 1987. Production then switched to the Sierra II. Both boats were built at Gorkhy (now Nizhny Novgorod) and then transferred by barge along the Russian river/canal complex to Severodvinsk for fitting out.



'Sierra I' class SSN showing its exceptionally long sail (333 Sqn RNor AF)

DESIGN

The Sierra design is similar to the single 'Mike' class SSN (which was lost in an accident in April 1989) in having a strengthened titanium hull. This makes it considerably more expensive than the 'Akula' class and it would appear that it is the successor to the 'Alfa' class.

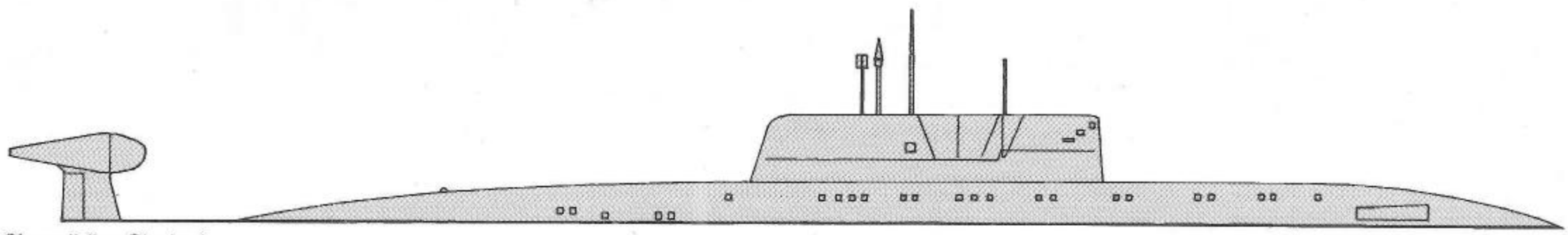
The standoff distance between the hulls is considerable, giving obvious benefits in reducing radiated noise and in inhibiting the effect of torpedoes.

There is a pod on the after fin for a thin-line, towed array, which is considerably larger than that in the Victor III. The Sierra I was the first Russian submarine to be fitted with the releasable 'crew pod' which shows up as a 'V-shape' in close-ups of the sail. The second of the class also has a bulbous casing at the after end of the fin for a towed communications buoy.

DEPLOYMENT

Both have spent their operational careers in the Northern Fleet, but are now believed to be in reserve.

SIERRA II



Sierra II (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia

Class: SIERRA II (BARACUDA II) (TYPE 945B)

Built: 2
Active: 2
Building: 0

Displacement:
surfaced: 7,600 t
submerged: 9,120 t

Dimensions
Length: 111 m (364.2 ft)
Beam: 14.2 m (46.6 ft)
Draught: 8.8 m (28.9 ft)

Speed, submerged: 32 kts
Diving depth: 750 m (2,460 ft)

Complement: 115

SUBMARINES

ZUBATKA (K 239)

Builder	Nizhny Novgorod
Launched	Jul 1989
Commissioned	Oct 1990

OKUN (K 276)

Builder	Nizhny Novgorod
Launched	Jul 1992
Commissioned	12 Aug 1993

WEAPONS SYSTEMS

TUBES

Eight 650 mm (25.6 in) tubes.
Total weapon load not known.

TORPEDOES

Combination of 650 mm and 533 mm torpedoes with tube liners used for 533 mm (21 in) weapons.

SS-N-21 (NATO = Sampson)

SS-N-21 (NATO = Sampson) is a land attack missile launched from 533 mm (21 in) torpedo tubes and is the Russian equivalent to the US Tomahawk. Like that American missile, the SS-N-21 flies at low altitude (approximately 200 m (656 ft)) using a terrain-following guidance system. SS-N-21 has a range of some 1,620 n miles (3,000 km) and an accuracy (cep) of 150 m (492 ft), making it a formidable land attack weapon, although it has yet to demonstrate its potential as dramatically as did Tomahawk missiles in the Gulf War. There are two other versions of this missile: a surface ship-launched missile — SSC-4, and an air-launched missile — AS-15 Kent.

Specifications
Length: 8.09 m (26.54 ft)
Diameter: 0.51 m (20 in)
Wing span: 2.5 m (8.2 ft)
Weight: 1,700 kg (3,748 lb)
Speed: Mach 0.7
Altitude: Approx 200 m (656 ft)
Range: 1,620 n miles (3,000 km)
Guidance: Inertial/terrain-following
Warhead: Nuclear 200 kT
Accuracy — circular error probable (cep): 0.08 n miles (150 m)

SS-N-15 (NATO = Starfish)

SS-N-15 (Starfish) long-range anti-submarine weapon system is believed to be similar in shape to SUBROC, having a long, slim cylinder with small, retractable fins and a booster rocket at the end. SS-N-15 is associated with a low-frequency, bow-mounted, active/passive sonar system with 6 m (19.7 ft) diameter array (NATO = Shark Teeth). The weapon is loaded into a standard 533 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-15 payload is either a 200 kT nuclear depth charge or a Type 40 lightweight torpedo and it should be noted that, under current international agreements, nuclear warheads would not be carried at sea; the capability, however, remains.

Specifications
Length: 6.5 m (21.33 ft)
Diameter: 533 mm (21 in)
Wing span: n/k
Weight: 1,800 kg (3,968 lb)
Range: 24-27 n miles (45-50 km)
Speed: n/k
Guidance: Inertial

SS-N-16

SS-N-16 (NATO = Stallion) is a 650 mm tube-launched missile associated with the Shark Gill sonar system, which is integrated with a passive, towed array sonar. The weapon is loaded into a standard 650 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-16 payload is usually an E45-75A lightweight torpedo with a range of 8.1 n miles (15 km) at 30 knots. The torpedo has both passive and active sonar sensors and a warhead of either 100 kg (some sources say 90 kg) high explosives (SS-N-16A Veder) or a nuclear warhead of undetermined power (SS-N-16B Vodopod), although under current international agreements, nuclear warheads would not be carried at sea, but the capability, of course, remains.

Specifications
Length: 6.7 m (21.98 ft)
Diameter: 650 mm (25.61 in)
Wing span: n/k
Weight: 1,850 kg (4,078 lb)
Range: 50 n miles (92 km)
Speed: n/k
Guidance: Inertial

MINES

Maximum of 60 mines in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Rim Hat

Rim Hat radar warning receiver consists of a number of intercept antennas mounted in a circle at the base of the Snoop Pair motor drive unit.

Park Lamp

Park Lamp is a mast-mounted VLF/LF receiving antenna, consisting of two open loops at right angles to each other.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS

Pert Spring Satcom.

RADAR

Snoop Pair
Snoop Pair is a radar/ESM/datalink complex with back to back antennas, one for an I-band surface search radar and the other for ESM/datalink at the top of the mast.

SONARS

Shark Gill
Shark Gill is a hull-mounted, passive/active search and attack sonar, operating at low/medium frequencies.

Mouse Roar
Mouse Roar is a hull-mounted, active, high-frequency, attack sonar.

Skat 3
Skat 3 is a towed array.

PROPULSION

Specifications
System: Nuclear
Reactors: Tone VM-5 pressurised water reactor (PWR); 190 MW
Turbines: 2 turbo-alternators; 70 MW (95,000 hp(m))
Shaft: 1
Spinners: 2

FURTHER INFORMATION

PROGRAMME

After the launch of the second Sierra I in 1986 there was a four-year gap before the appearance of the first Sierra II in 1990. This was followed three years later by a second of the class, but the third was scrapped before completion in July 1992.

DESIGN

The Sierra II has a 5 m (16.4 ft) longer hull than the Sierra I and a markedly larger pod for the Skat 3 tower array. One of the most curious features, however, is the large square-sided and flat-topped sail, which sits on the hull like a packing-case, and is no less than 5 m (16.4 ft) longer than that in the Sierra I. It seems to make no allowance for hydrodynamic quieting; there is a flat face and there is no attempt to fair the sides of the sail into the hull. The masts are all on the starboard side, apparently to make space for two escape pods, rather than the one as in all other Russian SSNs, on the port side. A ten-point environmental sensor is fitted on the starboard side of the sail.

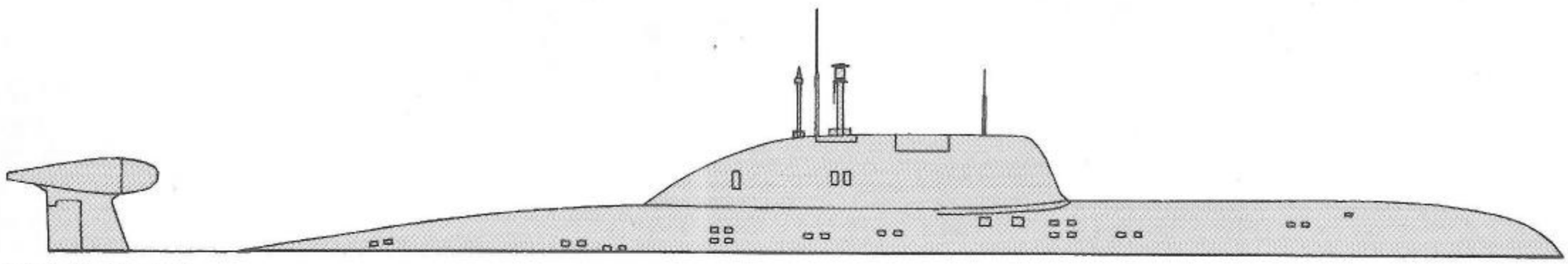
The standoff distance between the two hulls is considerable, with obvious advantages for radiated noise reduction and damage resistance.

OPERATIONAL

Both are based in the Northern Fleet.

Sierra II showing the stern pod for the towed array. The large sail has a unique, squat shape and houses a crew escape pod, whose outline can just be made out. The spur on the starboard side of the sail houses hydrodynamic sensors

AKULA



Akula (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia

Class: AKULA I, IMPROVED AKULA I and AKULA II (BARS) (TYPE 971)

Displacement:
surfaced: 7,500 t
submerged: 9,100 t

Dimensions
Length, overall:
Akula I/Improved Akula I: 110 m (360.1 ft)
Akula II: 114.0 m (374.0 ft)
Beam: 14 m (45.9 ft)
Draught: 10.4 m (34.1 ft)

Speed, submerged: 28 kts
Diving depth: 400 m (1,300 ft)

Complement: 85

SUBMARINES

Akula I

PUMA (K 254)
Builder Komsomolsk Shipyard, Russia
Launched Jul 1984
Commissioned Nov 1984

(K 263)
Builder Komsomolsk Shipyard, Russia
Launched May 1986
Commissioned Sep 1986

(K 322)
Builder Komsomolsk Shipyard, Russia
Launched Jul 1987
Commissioned Nov 1987

BARS (K 480)
Builder Severodvinsk Shipyard, Russia
Launched May 1988
Commissioned Oct 1988

JAGUAR (K 391)
Builder Komsomolsk Shipyard, Russia
Launched Apr 1989
Commissioned Jul 1989

PANTHER (K 317)
Builder Severodvinsk Shipyard, Russia
Launched May 1990
Commissioned Oct 1990

RYS (K 331)
Builder Komsomolsk Shipyard, Russia
Launched Jun 1990
Commissioned Sep 1990

WOLF (K 461)
Builder Severodvinsk Shipyard, Russia
Launched Jun 1991
Commissioned Dec 1991

Improved Akula I

COUGAR (K 419)
Builder Komsomolsk Shipyard, Russia
Launched May 1992
Commissioned Aug 1992

LEOPARD (K 328)
Builder Severodvinsk Shipyard, Russia
Launched Jun 1992
Commissioned Oct 1992

TIGER (K 157)
Builder Severodvinsk Shipyard, Russia
Launched Jun 1993
Commissioned Oct 1993

DRAGON (K 267)
Builder Komsomolsk Shipyard, Russia
Launched Sep 1994
Commissioned 29 Jul 1995

Akula II

VEPR (K -)
Builder Severodvinsk Shipyard, Russia
Launched Dec 1994
Commissioned Jul 1995

GEPARD (K -)
Builder Komsomolsk Shipyard, Russia
Launched May 1996
Commissioned 1997

BISON (K -)
Builder Severodvinsk Shipyard, Russia
Launched Jul 1996
Commissioned 1997

WEAPONS SYSTEMS

TUBES

Akula I — four 533 mm (21 in) and four 650 mm (25.6 in) tubes.
Improved Akula I and Akula II — as Akula I plus six 533 mm (21 in) external tubes in upper bow.
Total weapons Akula I — 40; improved Akula I/Akula II — 46.

TORPEDOES

SS-N-21 (NATO = Sampson)

SS-N-21 (NATO = Sampson) is a land attack missile launched from 533 mm (21 in) torpedo tubes and is the Russian equivalent to the US Tomahawk. Like that American missile, the SS-N-21 flies at low altitude (approximately 200 m (656 ft)) using a terrain-following guidance system. SS-N-21 has a range of some 1,620 n miles (3,000 km) and a cep of 150 m (492 ft), making it a formidable land attack weapon, although it has yet to demonstrate its potential as dramatically as did Tomahawk missiles in the Gulf War. There are two other versions of this missile: a surface ship-launched missile — SSC-4, and an air-launched missile — AS-15 Kent.

Specifications
Length: 8.09 m (26.54 ft)
Diameter: 0.51 m (20 in)
Wing span: 2.5 m (8.2 ft)
Weight: 1,700 kg (3,748 lb)
Speed: Mach 0.7
Altitude: Approx 200 m (656 ft)
Range: 1,620 n miles (3,000 km)
Guidance: Inertial/terrain-following
Warhead: Nuclear 200 kT
Accuracy — circular error probable (cep): 0.08 n miles (150 m)

SS-N-15 (NATO = Starfish)

SS-N-15 (Starfish) long-range anti-submarine weapon system is believed to be similar in shape to SUBROC, having a long, slim cylinder with small, retractable fins and a booster rocket at the end. SS-N-15 is associated with a low-frequency, bow-mounted, active/passive sonar system with 6 m (19.7 ft) diameter array (NATO = Shark Teeth). The weapon is loaded into a standard 533 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and drives it to the surface and on into the atmosphere where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-15 payload is either a 200 kT nuclear depth charge or a Type 40 lightweight torpedo and it should be noted that, under current international agreements, nuclear warheads would not be carried at sea; the capability, however, remains.

Specifications
Length: 6.5 m (21.33 ft)
Diameter: 533 mm (21 in)
Wing span: n/k
Weight: 1,800 kg (3,968 lb)
Range: 24-27 n miles (45-50 km)
Speed: n/k
Guidance: Inertial

SS-N-16 (NATO = stallion)

SS-N-16 (NATO = Stallion) is a 650 mm tube-launched missile associated with the Shark Gill sonar system, which is integrated with a passive, towed array sonar. The weapon is loaded into a standard 650 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine. The rocket motor ignites and

drives it to the surface and on into the atmosphere where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-16 payload is usually an E45-75A lightweight torpedo with a range of 8.1 n miles (15 km) at 30 knots. The torpedo has both passive and active sonar sensors and a warhead of either 100 kg (some sources say 90 kg) high explosives (SS-N-16A Veder) or a nuclear warhead of undetermined power (SS-N-16B Vodopod), although under current international agreements, nuclear warheads would not be carried at sea, but the capability, of course, remains.

Specifications

Length: 6.7 m (21.98 ft)
Diameter: 650 mm (25.61 in)
Wing span: n/k
Weight: 1,850 kg (4,078 lb)
Range: 50 n miles (92 km)
Speed: n/k
Guidance: Inertial

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Amber Light
Amber Light is an intercept antenna.

Rim Hat
Rim Hat radar warning receiver consists of a number of intercept antennas mounted in a circle at the base of the Snoop Pair motor drive unit.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS

Park Lamp
Park Lamp is a mast-mounted VLF/LF receiving antenna, consisting of two open loops at right angles to each other.

Pert Spring
Pert Spring Satcom.

RADAR

Snoop Pair
Snoop Pair is a radar/ESM/datalink complex with back to back antennas, one for an I-band surface search radar and the other for ESM/datalink at the top of the mast.

SONARS

Shark Gill
Shark Gill is a hull-mounted, passive/active search and attack sonar, operating at low and medium frequencies.

Mouse Roar
Mouse Roar is a hull-mounted, active attack, high-frequency sonar.

Skat 3
Skat 3 is a towed, passive, very low-frequency array.

PROPULSION

Specifications

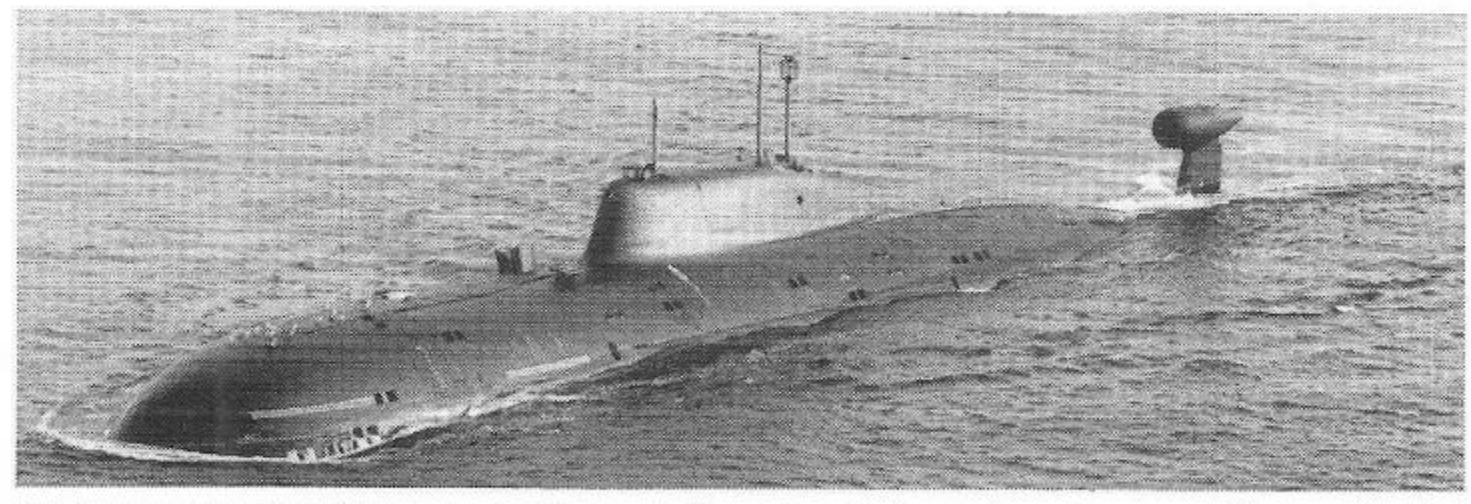
System: Nuclear
Reactors: 1 VM-5 pressurised water reactor (PWR); 190 MW
Steam turbines: 2 GT3A; 35 MW (47,600 hp(m))
Shafts: 1
Spinners: 2

FURTHER INFORMATION

PROGRAMME

The 'Akula' class is the follow-on to the 'Victor III' class, with the first of the new boats being launched in July 1984 at Komsomolsk and becoming operational at the end of 1985. The class was then in series production at Severodvinsk and Komsomolsk with a construction rate of between one and two per year.

Hull numbers one to eight (*Puma* (K 284) to *Wolf* (K 461)) are classified as Akula Is, while the next four (*Cougar* (K 419) to *Dragon* (K 267)) are classified as Improved Akula Is. *Vepr* (K -) and subsequent hulls are Akula IIs.



Akula I. The objects on the casing just forward of the sail are for hydrodynamic sensors. The way in which the sail is faired smoothly into the hull is in marked contrast to the stark right-angles in the Sierra II (see previous entry)

DESIGN

The 'Akula' class was designed by the Malakhit Design Bureau in St Petersburg and has the same broad hull as Sierra, but with lower radiated noise levels than the Victor III. All Akulas also have a large pod on the vertical stern fin for the Skat 3 thin-line, towed sonar array and a rescue pod for the crew in the sail; the U-shaped outline of the pod can just be discerned in most photographs.

One of the more notable external features of the 'Akula' class as a whole is the very long fin, which is very carefully faired into the hull, in contrast to most other submarine designs where the fin/hull junction is a stark 90°. This may well be one of the products of the long-standing Russian study into aquatic life-forms such as whales, sharks and porpoises, and is almost certainly intended to cut down hydrodynamic swirl — and thus noise.

Earlier Russian submarines were renowned in the West for their large noise signatures, but it is clear that this is no longer the case and considerable efforts have been put into noise reduction for this class. Indeed, the design is being continually improved with reduced noise levels, boundary-layer suppression and active noise cancellation reported in the later submarines, and one of the major reasons for the 3.7 m (12.14 ft) longer hull in the Akula II is to enable it to accommodate yet further noise reduction measures. It is noteworthy that the US DoD's chart comparing Russian and US SSN noise levels (see introduction to this section) shows a very marked difference between the original Akula design and the Improved Akula, with the Severodvinsk forecast to offer only a marginal improvement.

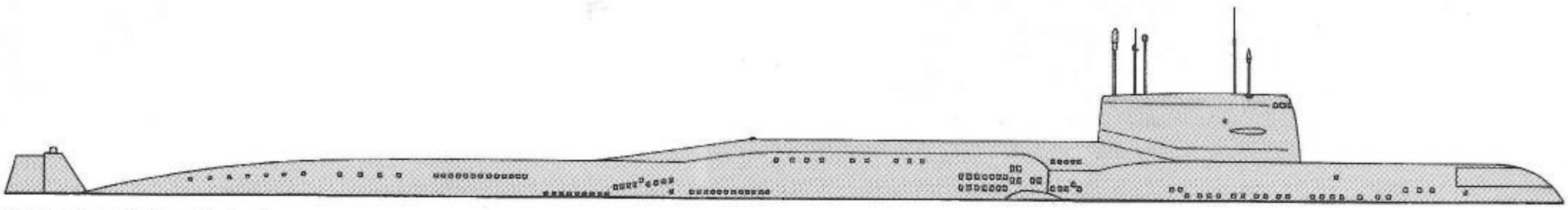
The Improved Akula Is and the Akula IIs both have six additional 533 mm (21 in) torpedo tubes mounted in the forward casing and outside the pressure hull, which makes them impossible to reload at sea. It is presumed that these are for SS-N-21 missiles and that the reasoning behind them is the same as for the vertical launch tubes in the later US Navy 'Los Angeles' class; that is, to create extra space inside the pressure hull for torpedo reloads. Presumably, however, there is no space between the inner and outer hulls of the 'Akula' class for the missile tubes to be launched vertically.

One of the distinguishing features of the Akula II is a number of prominent non-acoustic sensors on the sail leading-edge and on the forward casing. These are similar to devices tested on a Hotel II class from the early 1980s.

DEPLOYMENT

The Komsomolsk-built submarines serve with the Pacific Fleet and the Severodvinsk-built boats with the Northern Fleet. It is, however, reported that the first two (K 284 and K 253) may have been paid off already.

YANKEE NOTCH



Yankee Notch (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia

Class: YANKEE NOTCH (GROSHA) (TYPE 667AR)

Converted: 3
Active: 3
Building: 0

Displacement:
surfaced: 8,500 t
submerged: 10,300 t

Dimensions
Length: 141.5 m (464.2 ft)
Beam: 11.6 m (38.1 ft)
Draught: 8.1 m (26.6 ft)

Speed, submerged: 26 kts
Diving depth: 320 m (1,050 ft)

Complement: 109 (18 officers)

SUBMARINES

K 418 K 403 K 422

WEAPONS SYSTEMS

TUBES

14—533 mm (21 in) tubes. There are six torpedo tubes in the bow, plus six additional tubes, three mounted in each of the two 'notches' (see 'Design' notes below). Total weapons carried are 18 for the bow tubes and 41 (six in tubes plus 35 in the magazine) for the tubes in the 'notch'.

TORPEDOES

Combination of 533 mm torpedoes (see table).

SS-N-21 (NATO = Sampson)

SS-N-21 (NATO = Sampson) is a land attack missile launched from 533 mm (21 in) torpedo tubes and is the Russian equivalent of the US Tomahawk. Like that American missile, the SS-N-21 flies at low altitude (approximately 200 m (656 ft)) using a terrain-following guidance system. SS-N-21 has a range of some 1,620 n miles (3,000 km) and a cep of 150 m (492 ft), making it a formidable land attack weapon, although it has yet to demonstrate its potential as dramatically as did Tomahawk missiles in the Gulf War. There are two other versions of this missile: a surface ship-launched missile — SSC-4, and an air-launched missile — AS-15 Kent.

Specifications
Length: 8.09 m (26.54 ft)
Diameter: 0.51 m (20 in)
Wing span: 2.5 m (8.2 ft)
Weight: 1,700 kg (3,748 lb)
Speed: Mach 0.7
Altitude: Approx 200 m (656 ft)
Range: 1,620 n miles (3,000 km)
Guidance: Inertial/terrain-following
Warhead: Nuclear 200 kT
Accuracy — circular error probable (cep): 0.08 n miles (150 m)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Brick Spit/Brick Pulp
Brick Spit and Brick Pulp are ESM systems, presumably used for surveillance and threat warning.

COMMAND AND CONTROL SYSTEMS

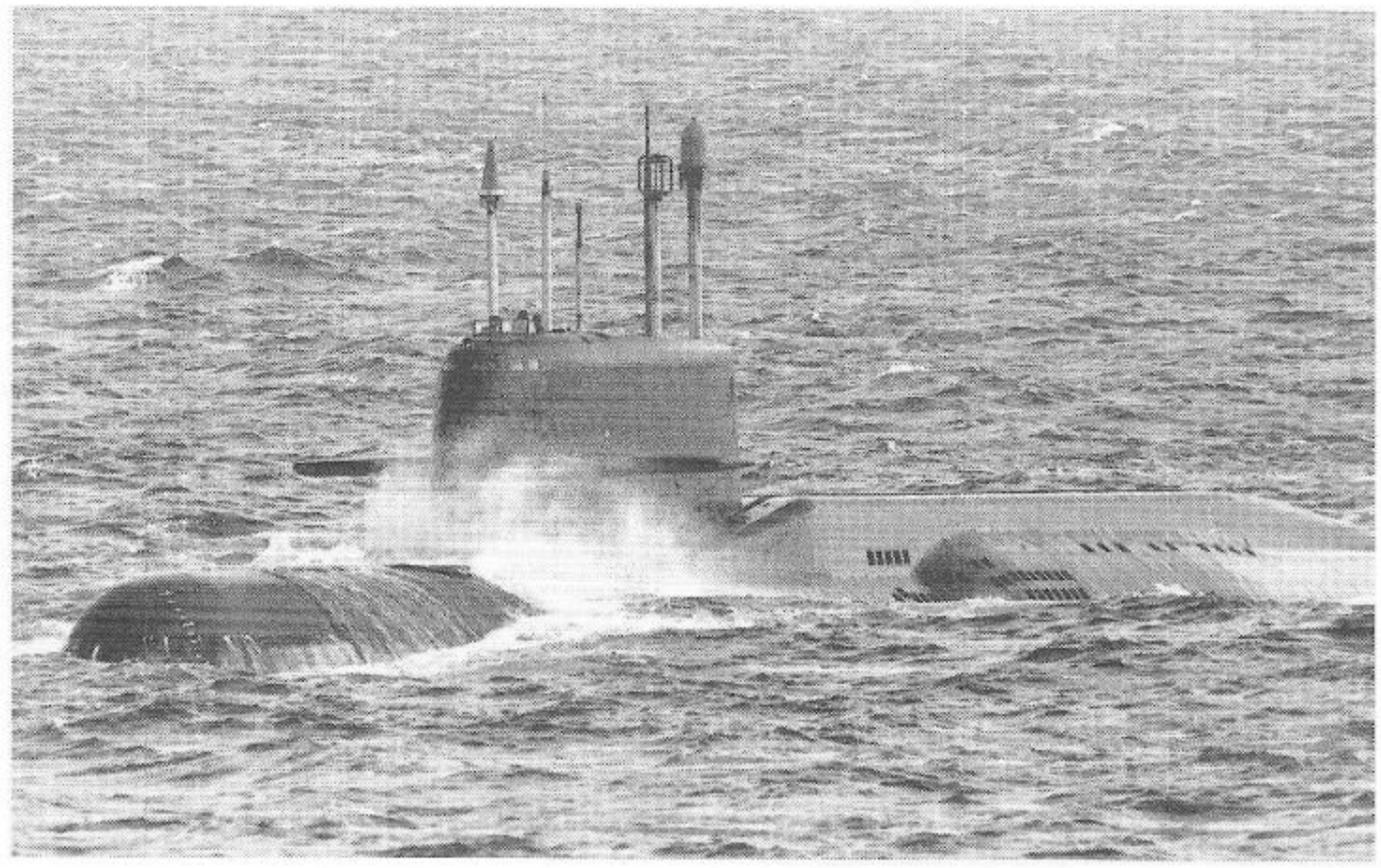
COMMUNICATIONS

Park Lamp
Park Lamp is a mast-mounted VLF/LF receiving antenna, consisting of two open loops at right angles to each other.

VLF communications buoy.
VHF and UHF aerials.
Kremmny 2 IFF.

RADAR

Snoop Tray
Snoop Tray is a mast-mounted, I-band, surface search radar antenna.



A converted 'Yankee' class submarine showing the curved casing which gave rise to its designation 'Yankee Notch' by NATO

SONARS

Shark Teeth
Shark Teeth is a hull-mounted, low/medium-frequency, passive/active search and attack sonar

Mouse Roar
Mouse Roar is a hull-mounted, active attack, high-frequency sonar.

NAVIGATION

SINS
Satnav.

PROPULSION

Specifications
System: Nuclear
Reactors: 2 VM-4 pressurised water reactors (PWR); 155 MW

Steam turbines: 2 GT-3A-635; 38.2 MW (52,000 hp(m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

Although the Soviet Navy built the 'Hotel' class in the late 1950s, armed with SLBMs mounted vertically in the sail, the 'Yankee' class was the first to have a large number of missiles mounted within the hull. 33 Yankee Is, armed with 16 SS-N-6 entered service between 1966 and 1971.

The Soviet Navy adhered to the limits, agreed under SALT I, of 62 SSBNs and 950 SLBMs, which resulted in the conversion of many 'Yankee' class boats as summarised in the table below.

Russian Navy 'Yankee' class submarines

Designation	Number	Russian Type No	Date	Role	
Yankee II	1	Project 667 AM	1978 - entered service	Trials of SS-NX-17 SLBM; 12 tubes	a. SS-NX-17 did not enter full-scale production
Yankee III	1 + ?		1983 - entered service	SSN	The Yankee conversion to SSN was first seen in 1983. The conversion seemed to take about two years and it appeared to be intended to convert about 10 of the class, but the programme was cut for financial reasons in 1989-90.
?	1	Project 667 M	1985 - started trials 1988 - paid off	Trials of SS-NX-24 cruise missiles; 12 in vertical tubes	a. Launch tubes in enlarged centrebody; speed and manoeuvrability both reduced
Yankee Pod	1	Project 09774	1984	Sonar test platform	a. Lengthened by 4 m (13.12 ft) b. Fitted with two towed arrays: one deployed from pod, the other from a fin-mounted tube c. New type of bow array d. This may also have been designated Yankee III
Yankee Stretch	1	Project 09780	1990	Mother ship for mini-submarines.	a. Lengthened by 30 m (98.5 ft) b. Missile tubes removed
Yankee Notch	4	Project 667AT	1984-88	SS-N-21 cruise missile launcher	

DESIGN

The Yankee Notch conversion has resulted in an increase of 12 m (39.4 ft) as a result of the 'notch waisted' central section, despite the removal of the ballistic missile section. This new section houses three 533 mm (21 in) tubes amidships on each side, while the magazine holds up to 35 SS-N-21s or additional torpedoes and mines. There may also have been a rearrangement of torpedo tubes to include some 650 mm (25.6 in) tubes.

OPERATIONAL

All three are operational and are based in the Northern Fleet.

SEVERODVINSK

Severodvinsk (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia

Class: SEVERODVINSK (TYPE 885)

Active: 0
Building: 3
Proposed: 4

Displacement:
surfaced: 9,500 t
submerged: 11,800 t

Dimensions
Length: 120 m (394 ft)
Beam: 15 m (49 ft)
Draught: 10 m (33 ft)

Speed, submerged: 28 kts

Complement: 85

SUBMARINES

BISON (?) (K-?)
Builder Severodvinsk Shipyard, Russia

Laid down 21 Dec 1993
Launched 1996
Commissioned 1998

WEAPONS SYSTEMS

TUBES

Four 650 mm (25.6 in) tubes.
Two 533 mm (21 in) tubes.

SUBMARINE-LAUNCHED CRUISE MISSILES

SS-N-15.
SS-N-16.

SS-CX-5 Sapless
There are eight vertical launch tubes for this Sub Harpoon-type cruise missile (it's US nickname is 'Harpoonski').

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Radar warning.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

There will be a sophisticated command and control system.

RADAR

Surface search; probably I-band.

SONARS

Bow-mounted, low-frequency spherical array, used for passive/active search and attack.

Flank array
Towed, passive arrays, using very low frequencies.

PROPULSION

Specifications
System: Nuclear
Reactors: 2 pressurised water reactors (PWR); 200 MW

Steam turbines: 2
Shafts: 1

FURTHER INFORMATION

PROGRAMME

The construction programme was confirmed in 1993 and the first submarine was launched in 1995, with reports suggesting that there are plans to build at least seven. The building programme has, however, already been severely disrupted by shipyard funding problems, with many workers claiming not to have been paid for many months, while subsidiary suppliers are existing on credit, a situation which cannot continue for much longer.

DESIGN

A US DoD artist's sketch of the *Severodvinsk* shows that the submarine has a large cylindrical bow sonar, the first in a Russian submarine. Unlike US SSNs, however, the torpedo tubes have not been moved back to an amidships position, but are well forward and well down in the hull; they also appear to be canted outwards to launch their torpedoes either side of the array. The sail (and thus the command centre) is well forward. Other SSNs launch their cruise missiles either from their bow tubes, or, in the case of the later US 'Los Angeles' class, from vertical tubes mounted in the

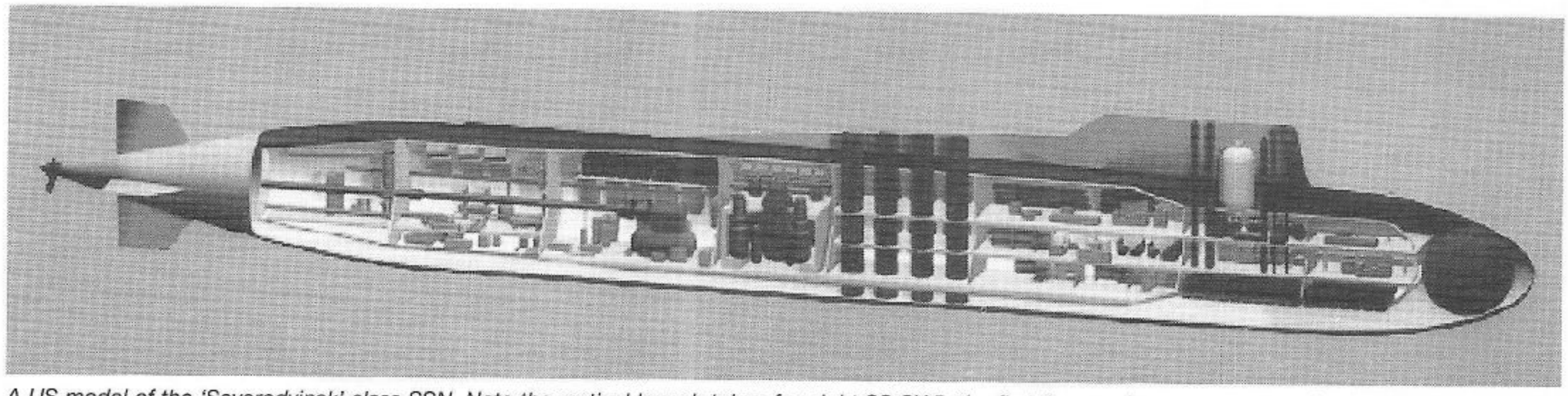
bows. In the *Severodvinsk,* however, the Russian designers, never reluctant to be innovative, have mounted the launch tubes in two vertical rows of four abaft the sail, in a manner similar to that used for SSBNs.

An official Russian statement describes the *Severodvinsk* as 'a multipurpose design, based on that of the Akula II.' In the information so far released, however, the two types appear to have very little in common, suggesting that the *Severodvinsk* is, in fact, a totally new design.

There is no evidence yet that Russian designers are adopting the pumpjet propulsor for yet further quietening.

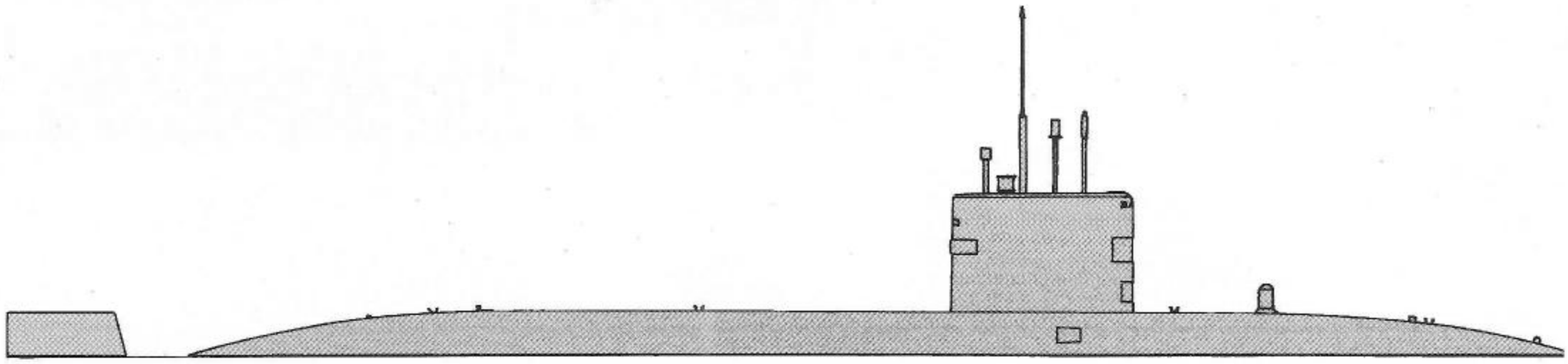
DEPLOYMENT

It is anticipated that the first of class will undertake the lengthy trials always required of such a vessel, and will eventually join the active fleet in about 2000-2002.



A US model of the 'Severodvinsk' class SSN. Note the vertical launch tubes for eight SS-CX-5, the first time such an arrangement has been used for cruise missiles (US Navy)

SWIFTSURE



Swiftsure (Ian Sturton)

GENERAL SPECIFICATIONS

Country: United Kingdom

Class: SWIFTSURE

Built: 6
Active: 5
Building: 0

Displacement:
surfaced: 4,000 t light; 4,400 t standard
submerged: 4,900 t

Dimensions
Length: 82.9 m (272 ft)
Beam: 9.8 m (32.3 ft)
Draught: 8.5 m (28 ft)

Speed: 30+ kts dived

Complement: 116 (13 officers)

SUBMARINES

SOVEREIGN (S 108)

Builder	Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Ordered	16 May 1969
Laid down	18 Sep 1970
Launched	17 Feb 1973
Commissioned	11 Jul 1974

SUPERB (S 109)

Builder	Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Ordered	20 May 1970
Laid down	16 Mar 1972
Launched	30 Nov 1974
Commissioned	13 Nov 1976

SCEPTRE (S 104)

Builder	Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Ordered	1 Nov 1971
Laid down	19 Feb 1974
Launched	20 Nov 1976
Commissioned	14 Feb 1978

SPARTAN (S 105)

Builder	Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Ordered	7 Sep 1973
Laid down	26 Apr 1976
Launched	7 Apr 1978
Commissioned	22 Sep 1979

SPLENDID (S 106)

Builder	Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Ordered	26 May 1976
Laid down	23 Nov 1977
Launched	5 Oct 1979
Commissioned	21 Mar 1981

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas UGM-84B Sub-Harpoon Block 1C

All British SSNs and SSBNs carry Sub-Harpoon anti-ship missiles as part of their weapon load, which are either Block 1B or Block 1C versions. Block 1C has a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missiles).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

Five 533 mm (21 in) tubes.
Total weapons load, 25.

TORPEDOES

GEC-Marconi Spearfish

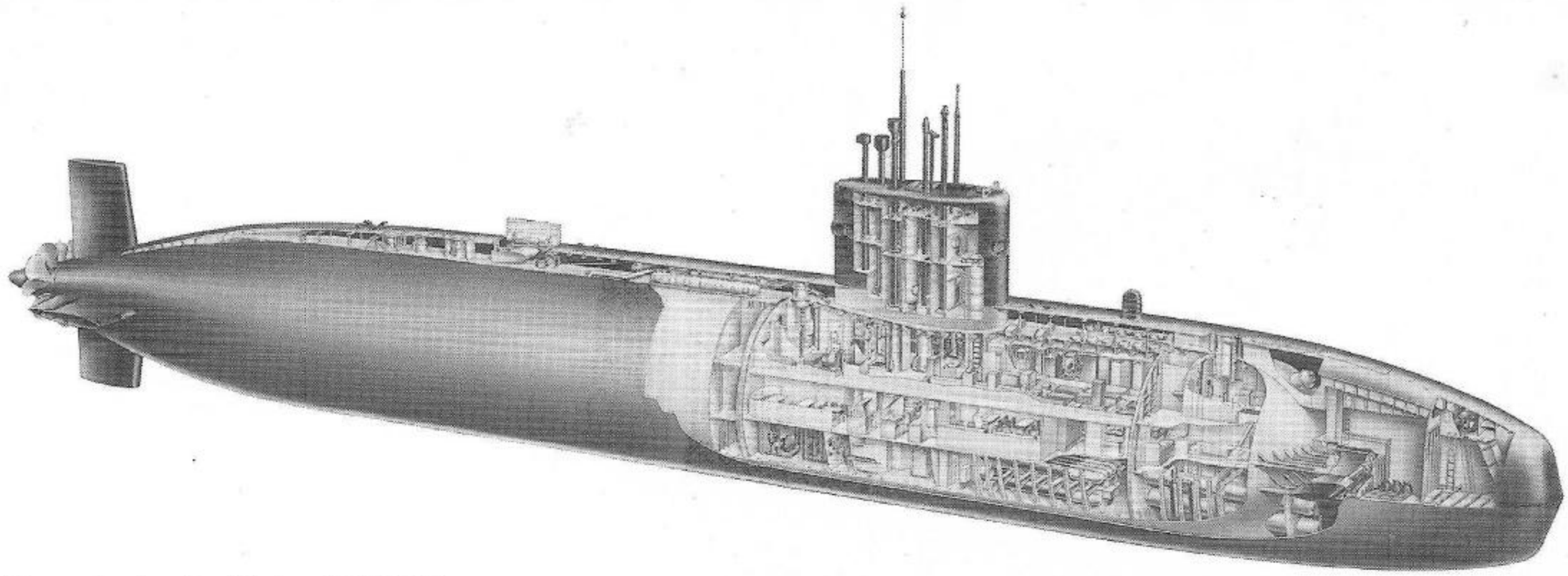
'Swiftsure' class submarines have been fitted to accommodate and launch the Spearfish torpedo during their mid-life refits.

Spearfish is a dual-purpose, wire-guided torpedo, designed to counter fast, deep diving, quiet and strong-hulled submarines as well as surface targets, where the acoustic fuzing system detonates the warhead under the hull, creating a whipping effect to break the ship's back. Primary operation is in the passive mode, but with an active mode for use against very quiet targets, or in the final stages of attack, where the powerful transmitters have a long detection range and 'burn through' enemy countermeasures. Target detection capabilities are further enhanced by an array with many times the search volume of Tigerfish, with frequency-agile transducers which enable salvo firing to be carried out.

The torpedo normally operates autonomously, relaying data back to the submarine, but the command team can assume control at any time. The wire is dispensed from two reels, one in the torpedo, the other in the submarine launch tube, using a dispenser which allows discharge at high submarine speeds as well as giving the submarine complete freedom of manoeuvre after launch. Spearfish contains a number of homing and tactics computers to control the weapon, enabling it autonomously to select search detection and attack modes, to classify signal returns, to decide on appropriate tactics including re-attacks on the target if necessary, and to classify, track and overcome countermeasures and decoys.

Specifications

Length: 7 m (22.96 ft)
Diameter: 533 mm (21 in)
Weight: 1,850 kg (4,078 lb) (in air)
Speed: Approx 65 kts (max)
Range: Active/passive homing to 14 n miles (26 km) at 70 kts; attack speed 55 kts
Warhead: 300 kg (661 lb) blast and shaped (directed-energy) PBX-104 warhead
Engine: Sundstrand 21TP01 gas turbine using Otto fuel.



Cutaway drawing of an 'S' class SSN (VSEL)

Manufacturer/Contractor
GEC-Marconi Underwater Weapons Systems Ltd, Waterlooville, Hampshire, UK

GEC-Marconi Mk 24 Tigerfish
Tigerfish uses the passive mode whenever possible, with the interrogation rate being progressively increased as the torpedo nears the target to improve system accuracy. The onboard computer performs several functions during the attack, including interrogation control, sonar data computation, torpedo steering control and data transmission to the submarine to update its computer memory. The onboard computer is connected through the guidance wire to the submarine's torpedo fire-control computer. During the wire-guidance phase the torpedo's computer responds to the demands of the submarine computer, with wire being dispensed from both torpedo and submarine to avoid any stress due to their relative motion. Wire guidance ceases at the point where the torpedo's automatic three-dimensional passive/active acoustic homing system can control the final run to the target and during this phase the torpedo computer interprets data from the homing system sensors to calculate and then command the appropriate course, subject to a priority overriding steer-off azimuth control from the submarine.

Specifications
Length: 6.46 m (21.19 ft)
Diameter: 533 mm (21 in)
Weight: 1,550 kg (3,417 lb) (in air)
Propulsion: Electrically driven contrarotating propellers
Speed: 24 kts (passive), 35 kts (active)
Range: 7.5-22 n miles (13-39 km) (estimated)
Max operating depth: 610 m (2,000 ft) (estimated)
Warhead: Royal Ordnance 134 kg (295 lb) PBXN 105 warhead
Fuze: Dual-action impact (inertia-type) and proximity (magnetic)
Power: 2 Chloride silver/zinc oxide batteries driving a 2-speed electric motor
Propellers: 2, contrarotating

Manufacturer/Contractor
GEC-Marconi Underwater Weapons Systems Ltd, Waterlooville, Hampshire, UK.

MINES

Stonefish mines can be carried in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Racal Outfit UAP (2)
The UAP(2) passive intercept ESM system (formerly UAC(1)) is specifically designed for British SSNs and functions through the search periscope. The system measures the parameters of received radar signals and compares them with a library of parameters. Signal identity, bearing and threat category are displayed in tabular format. Raw data on bearing and frequency are given on a display which can be overlaid with symbols and data derived from the signal analysis processor. Specific intercepts can be analysed in greater depth using a manual pulse analyser. The system incorporates the Racal Sadie signal analysis processor which permits data rates of up to 500,000 pps to be handled with no degradation. Additionally, a fully representative onboard trainer is integrated within the operator's console.

Manufacturer/Contractor
Racal Radar Defence Systems Ltd, Chessington, UK.

ELECTRONIC COUNTERMEASURES (ECM)

SSDE Mk 6
Two SSDE (Submarine Signal and Decoy Ejectors) Mk 6. There are two SSDEs, one forward, the other aft, which are used to eject decoys (for example, Type 2066 and Type 2071) and communications buoys, such as the ECB-680(1) and ECB-699 (see next page).

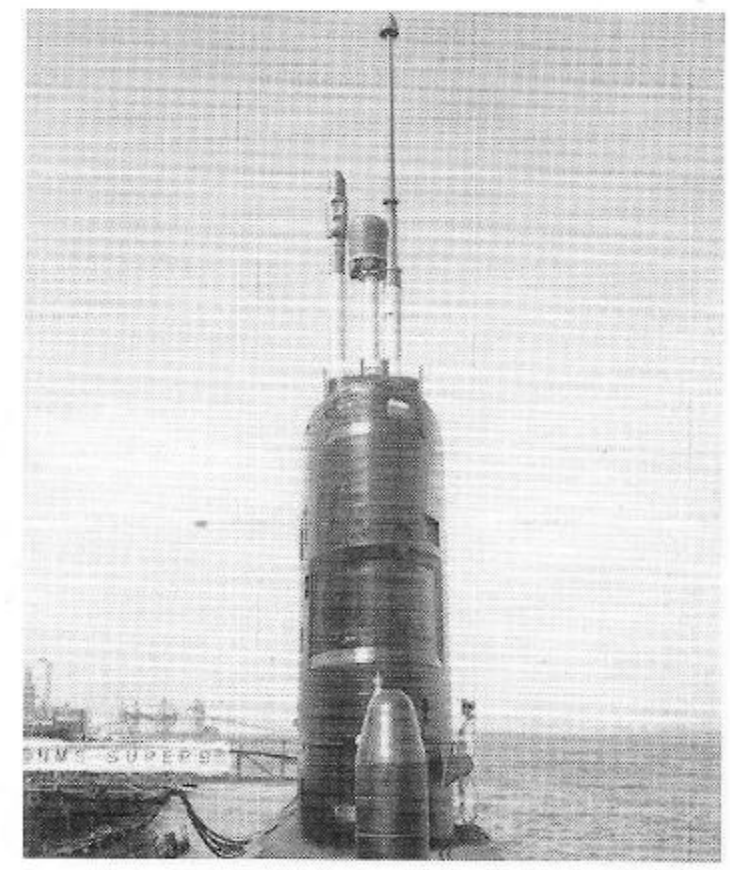
Manufacturer/Contractor
Strachan & Henshaw, Bristol, UK.

Type 2066
The Type 2066 is a torpedo decoy launched from the SSE.

Manufacturer/Contractor
Dowty, Ross-on-Wye, UK.

Type 2071 torpedo decoy
The Sonar Type 2071 (also known as UW300S) is a depth-compensated, low-frequency acoustic projector which transmits complex signals consisting of tones, noise bands or pulses to provide noise countermeasures against sonars and torpedo homing heads. The device consists of a user-programmable digital signal generator (DSG), a power amplifier, hydrosounder with pressure compensator and a test unit.

The DSG is capable of simultaneously generating up to 11 different signals, which may comprise single tones, swept tones, bands of random noise, modulated noise, or pulses. The type, frequency, amplitude and duration of these signals is programmed into the DSG using a keypad and displayed for the operator via a VDU. The DSG is able to store in memory up to eight sets of programs, thus eliminating the need to reprogram each time the system is used.



Racal UAP (2) ESM antennas visible aboard Superb *(S 109)* (Racal)

Prerecorded data may also be routed through the DSG.

Manufacturer/Contractor
Gearing & Watson (Electronics) Limited, Hailsham. Eastbourne, UK.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Outfit DCB
Outfit DCB is a mainframe AIO (Action Information Organisation) system designed to provide a clear tactical picture from all filtered sensor data and can perform target motion analysis (TMA) on up to 24 tracks. It is also designed to assist in the assessment of this tactical picture and to perform various tactical calculations. Outfit DCB has two Ferranti FM1600B computers, each with an operating speed of 200 Kips (thousand instructions per second) and a 700,000 word memory. Coral 66 software language is used, incorporating the KATE (Kalman Analysis and Track Evaluation) algorithm for TMA. The software package on all these systems has received numerous changes both to match enhanced sensor performance and to upgrade the system.

Computer-calculated firing solutions and the tactical

Operator in front of Outfit DCB displays (IDR/R Pengelley)

picture are shown on one screen and weapon settings on the other. The system is compatible with straight, pattern-running and wire-guided torpedoes as well as Sub-Harpoon missiles and can engage two targets and control two wire-guided torpedoes simultaneously. The system also monitors torpedo tube and weapons states, initialises the weapons before launch and controls the launch sequence through the fire-control console. The weapons interface provides prelaunch data, guidance commands and discharge equipment drive pulses to the appropriate tubes and weapons. Data from the control room is transferred to the weapons compartment digitally on two serial highways with responses on another two serial highways.

Outfit DCG has been added to the system to accept navigational, tactical and sensor data from Outfit DCB and use them to conduct intensive analysis, usually to assist the TMA (target motion analysis) function. Outfit DCG consists of an array processor capable of 8 Mflops (million floating point operations per second) and a 128,000 word mass memory device to hold long timespans of data.

The sonars in British nuclear submarines were developed as stand-alone elements, but a considerable degree of integration has been achieved through interface units, which federate the different sonar systems, thus enabling data from one to be relayed to another for processing and display.

The system is currently being upgraded by replacing the FM1600B computers with the F2420 which has an operating speed of 1.9 Mips (millions of instructions per second) and a memory of 2.3 million words. This upgrade makes possible integration with the weapon system databus, improved MMI (man/machine interface) and colour displays, an expanded database, improved tracking algorithms and the introduction of command aids. The replacement is carried out within 22 days, which is the length of an assisted maintenance period.

Manufacturer/Contractor
Ferranti-Thomson Sonar Systems, Stockport, UK.

Outfit CXA
Outfit CXA is the DASA (Daimler-Benz Aerospace) Telegon 6 communications direction-finding (CDF) equipment. It is to be upgraded in the near future.

Manufacturer/Contractor
DASA, Ulm, Germany.

COMMUNICATIONS

GEC-Marconi ECB-680(1)
The ECB-680(1) (Expendable Communications Buoy) system provides one-way, line of sight VHF/UHF radio communications relay between a submerged submarine and surface receivers. It is launched from an SSDE (submerged signal and decoy ejector) tube at all operational depths and speeds up to 15 knots. Prior to launch, the ECB is programmed with its signal operating parameters (time delay, frequency, mode, and so on) and the message (plain text or encoded) via the inboard control interface unit.

On release, it remains at depth until the preset delay has elapsed, enabling the submarine to leave the area, and then rises to the surface, deploys the flotation collar and antenna, and then starts to transmit the message. Transmissions are made in the VHF/UHF band between 168 MHz and 310 MHz, and may be in AM or FM mode. The message cycle allows up to three minutes of transmission, with a one-minute gap and may be repeated up to 60 times, allowing the buoy four hours' transmission time. On completion of the preset number of message cycles, the buoy scuttles automatically.

In an emergency, ECB-680(1) can be released with no programmed input, upon which it will rise immediately to the surface and automatically transmit a distress SARBE signal, in which role the internal battery will last in excess of eight hours.

Manufacturer/Contractor
GEC-Marconi Naval Systems, Templecombe, Somerset, UK.

ECB-699 communications buoy
The ECB-699 UHF Satellite Communications System provides a digital communications link from submarines to shore. A Control Interface Unit (CIU) is used to load messages, frequency and timing information for subsequent transmission, and also provides built-in test facilities. Having been programmed, ECB-699 is launched from the submarine's Submerged Signal Decoy Ejector (SSDE) at normal operating depths and speeds and rises to the surface where it waits for the programmed delay to elapse. It then automatically erects its antenna and transmits, via satellite, to the shore. If the submarine is in distress, the buoy can be used to transmit a distress signal on 406 MHz via the COSPAS/SARSAT system, which provides reliable, rapid, worldwide indication of the buoy's identity and location.

Specifications
Length: 502 mm
Diameter: 101 mm
Weight: 4.4 kg (9.7 lb)
Operating frequency range: 290-320 MHz
Channel Selection/Spacing: Multiple programmable frequencies at 25 kHz channel spacing
Data mode:
  preset: 2,400 bits/s
  selectable: 75, 300, 600, 4,800 and 9,600 bits/s
Transmission delay: Selectable up to 8 h
Message cycles: Up to 15 programmable messages, each repeated once
Transmit power output: 100 W ERP
RF transmission modes: Dual-phase, frequency shift keying (FSK)
Buoy scuttle: On completion of message cycle
Alert mode: COSPAS/SARSAT tone at 406 MHz

Manufacturer/Contractor
Ultra Electronics Sonar and Communication Systems, Greenford, UK.

Type 2081
The Type 2081 environmental suite is a non-acoustic system providing real-time information on prevailing oceanographic conditions. It employs conductivity, temperature and depth sensors to detect changes in water-mass types associated with ocean fronts, eddies, stratification, up-welling, coastal currents and ice, as well as to monitor changes in the speed of sound and seawater density.

Fluorescence is evaluated using a single-pulsed, xenon flashlamp, whose light is optically filtered and then focused through three separate transmission windows onto a volume of seawater just in front of each of three detector windows. Detection of the fluorescence from each of the three specimens is then passed via separate channels to a photomultiplier detector.

It is important in the increasingly sophisticated ASW battle, for a submarine to be aware of the bioluminescent activity it is itself generating as it passes through the water, since this may be detected by a submarine, equipped with suitable sensors. Thus, another of the functions of the Type 2081 is to monitor the submarine's own bioluminescent activity.

There are two sensor packs, each housed within a single titanium pressure case and mounted together in a sea-chest forward of the fin. The two packs are hard-mounted to the submarine casing, with the heads protruding into the water. Each pack has its own independent umbilical, terminating at the hull penetrator. The packs are powered from the submarine via the umbilical, which is also used to carry data to the inboard control unit.

Sonar 2081 is being fitted to all RN submarines and it may have been this system which was trialled by *Spartan* in 1994.

Specifications
Sensor pack
Length: 450 mm (1.47 ft)
Diameter: 280 mm (0.91 ft)
Weight: 28 kg (62 lb) approx
Material: Titanium

Manufacturer/Contractor
Chelsea Instruments, East Molesey, Surrey, UK.

RADAR

Type 1006 navigation radar

Specifications
Role: navigation
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 30 dB
Pulsewidth: 0.08/0.25/0.75 µs
Pulse repetition frequency: 725-1,000/1,450-2,000 pps
Scan rate: 26 rpm

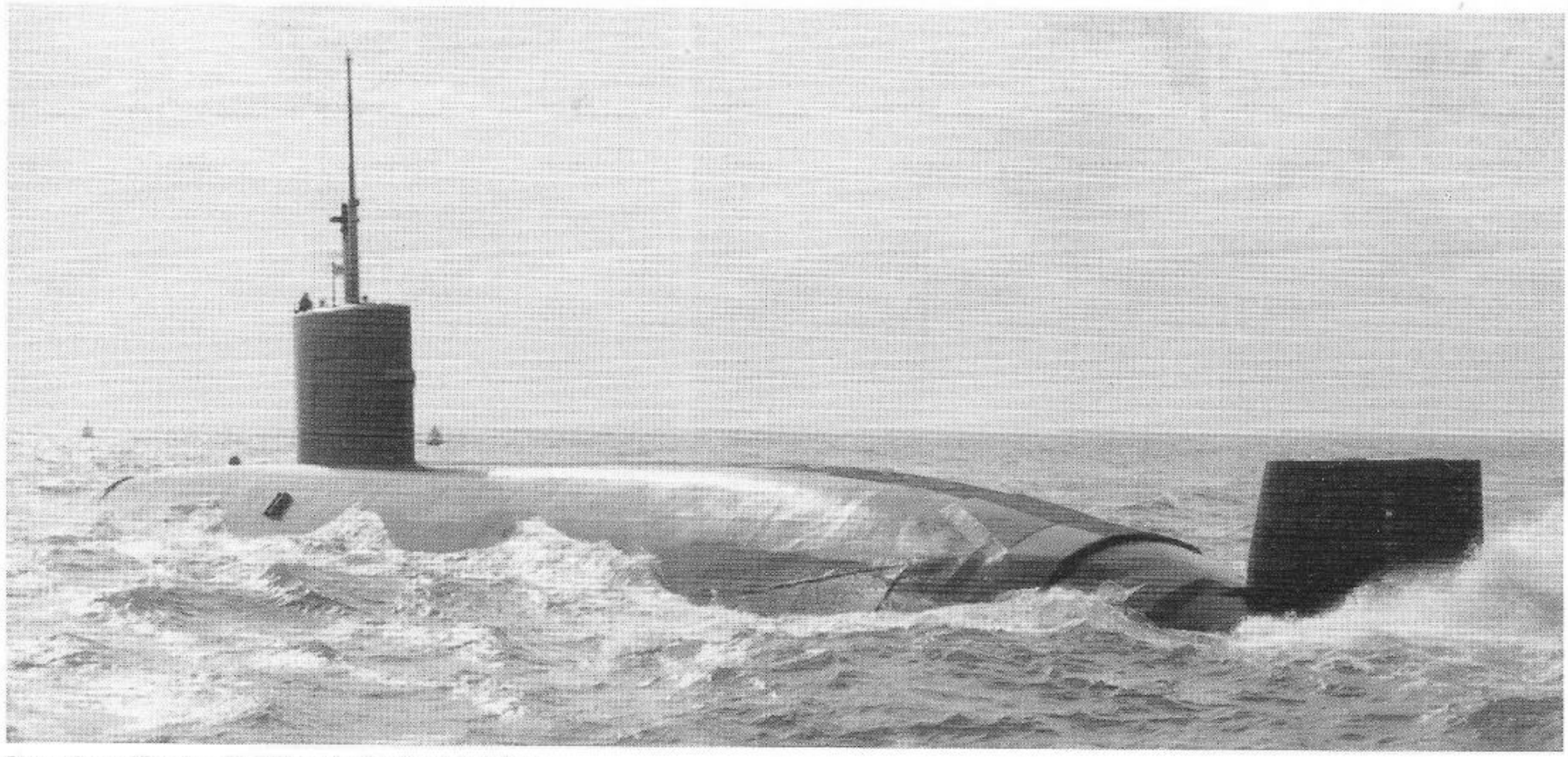
Manufacturer/Contractor
Kelvin Hughes, Ilford, Essex, UK.

SONARS

Type 2007
Type 2007 is a long-range passive flank array sonar, with three aligned arrays on either side of the submarine. It uses steerable beams and operates in the 1 to 3 kHz frequency range. It is used for initial detection at long range as well as for discovering bearings.

Manufacturer/Contractor
Graseby Marine, Watford, UK.

Type 2019
Type 2019, also known as PARIS (Passive Active Range Intercept Sonar), operates in the 1.75 to 14.5 kHz frequency range. It was designed and developed by Thomson Sintra. It is being replaced by Type 2082.



Stern view of Spartan *(S 105) on builder's trials* (VSEL)

Manufacturer/Contractor
GEC-Marconi, Sonar Systems Division, Templecombe, Somerset, UK.

Type 2020
Type 2020 is a bow-mounted, active/passive sonar, which has now replaced Type 2001 in most boats. It has a cylindrical array, providing 360° coverage with a 2 to 16 kHz passive frequency range. It is normally used in the passive mode but, when required, the active transmitter uses an automatic beam-steering unit with manual override. It transmits in the low- and medium-frequency bands, reportedly between 3 and 13 kHz.

Manufacturer/Contractor
GEC-Marconi, Sonar Systems Division, Templecombe, Somerset, UK.

Type 2026
The Type 2026, passive towed array sonar, is capable of detecting both broad and narrowband noise and includes sensitive hydrophones, a new broadband processor in the low-frequency band and a Curtis architecture processor.

Manufacturer/Contractor
GEC-Marconi, Sonar Systems Division, Templecombe, Somerset, UK.

Type 2046
Type 2046 is a towed, 50 m (164 ft) long, passive search array, operating at very low frequencies. It is used for long-range target detection, classification and tracking.

Manufacturer/Contractor
Ferranti-Thomson Sonar Systems, Stockport, UK.

Type 2074
Type 2074 is a hull-mounted, active/passive search and attack, low-frequency sonar, which replaces 2001 and/or 2020. It uses the Type 2020 array, but is still five times smaller than the equipment it replaces.

Manufacturer/Contractor
GEC-Marconi, Sonar Systems Division, Templecombe, Somerset, UK.

Type 2077
Type 2077 is a short-range classification sonar, currently being fitted. It is an active, high-frequency sonar, used for navigation under ice.

Manufacturer/Contractor
GEC-Marconi, Sonar Systems Division, Templecombe, Somerset, UK.

ELECTRO-OPTIC PERISCOPES

CK 33
Search.

CH 83
Attack.

Manufacturer/Contractor
Pilkington Optronics, St Asaph, Clywd, UK.

PROPULSION

Specifications
System: Nuclear
Reactor: 1 Roll-Royce PWR-1 (pressurised water reactor)
Steam turbines: 2 GEC; 11.2 MW (15,000 hp)
Shaft: 1
Propulsor: 1 shrouded pumpjet propulsor
Turbogenerators: 2 W H Allen turbogenerators; 3.6 MW
Diesel alternator: 1 Paxman diesel alternator; 1.42 MW (1,900 hp)
Emergency drive: 1 electric motor
Auxiliary drive: 1 retractable propeller

Helmsman at one-man control (OMC) aboard an 'S' class SSN (IDR/R Pengelley)

FURTHER INFORMATION

PROGRAMME

The first British SSN was *Dreadnought*, which was launched in 1960 and was powered by a Westinghouse S5W nuclear reactor bought from the United States. The bow section, however, including the Type 2001 sonar, was of entirely British design. Although the prototype, *Dreadnought* was a fully operational SSN and served until being stricken in February 1982.

The first entirely British SSN, *Valiant,* was completed in 1966 and was of generally similar design although 5.8 m (18 ft) longer. Four more of the class were built before production switched to the 'Swiftsure' class. The 'Valiant' class performed some notable feats, including sailing fully submerged from Singapore to the UK in 1967, a 10,000 n miles (18,500 km) submerged voyage, which took just 28 days. The Valiants were stricken in 1990-1992, except for the name ship — and thus eldest — which served on until 1994, when a propulsion-related accident brought her scheduled decommissioning date forward.

The first of the third class of British SSNs, the 'Swiftsure' class, joined the fleet in 1973. followed by the remaining five in 1974, 1976, 1978, 1979 and 1981, respectively.

DESIGN

The 'Swiftsure' class SSNs are 3.97 m (13 ft) shorter than the 'Valiant' class and have a much fuller form, with a flat upper casing indicating that the pressure hull maintains its diameter for much greater length than previous classes which had a distinctly 'hump-back' appearance. The sail is also lower and the retractable foreplanes are set further forward and lower.

There are five torpedo tubes (one less than in the Valiants) while the total weapon load of 20 is six less.

The Swiftsures are, however, deeper diving, faster and much quieter. Machinery is raft-mounted.

COSTS

At 1976 prices the costs of four of these SSNs were: *Swiftsure* — £37.1 million; *Superb* — £41.3 million; *Sceptre* — £58.9 million; *Spartan* — £68.9 million.

MODERNISATION

The six boats in the class started to enter mid-life refits from the mid-1980s onwards. *Swiftsure,* however, was found to have reactor problems of such seriousness that it was decided to scrap it and it was stricken in May 1992. Others in the class have, however, completed their refits and returned to service: *Sceptre* — 1987, *Spartan* — 1989, *Splendid* — 1993, *Sovereign* — 1995, and *Superb* — 1997.

These mid-life refits included fitting each with a PWR 1 Core Z, which gives a 12-year life cycle, although refits/refuel cycles will remain at eight to nine year intervals. Other improvements include acoustic elastomeric tiles, sonar 2074 processing equipment and improved decoys. Marconi/Plessey 2074 sonar has replaced 2020 and 2001.

Marconi Type 2077 short-range classification sonar is currently being fitted. Spearfish torpedoes are to be carried in due course.

Outfit DCB/DCG will be replaced by SMCS in due course.

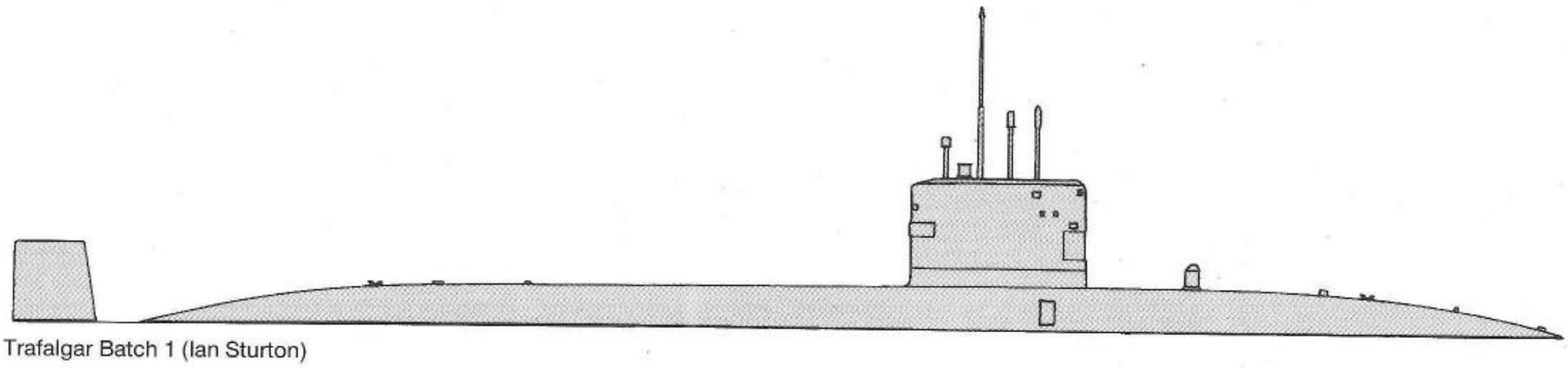
OPERATIONAL

All belong to the First Submarine Squadron based at Faslane, Scotland. In 1994 *Spartan* had a trial non-acoustic sensor fitted to the port side of the fin; this is believed to have been the Type 2081 sensor suite, which is now being fitted to all British submarines. Two of the class are usually in refit or extended maintenance.

THE FUTURE

The 'Swiftsure' class will be replaced by the 'Trafalgar Batch II' class in the first decade of the next century.

TRAFALGAR BATCH 1



Trafalgar Batch 1 (Ian Sturton)

GENERAL SPECIFICATIONS

Country: United Kingdom

Class: TRAFALGAR BATCH 1

Built: 7
Active: 7
Building: 0

Displacement:
surfaced: 4,740 t
submerged: 5,208 t

Dimensions
Length: 85.4 m (280.1 ft)
Beam: 9.8 m (32.1 ft)
Draught: 9.5 m (31.2 ft)

Speed, submerged: 32 kts
Diving depth: In excess of 300 m (985 ft)

Complement: 130 (18 officers)

SUBMARINES

TRAFALGAR (S 107)
Builder Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Ordered 7 Apr 1977
Laid down 25 Apr 1979
Launched 1 Jul 1981
Commissioned 27 May 1983

TURBULENT (S 87)
Builder Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Ordered 28 Jul 1978
Laid down 8 May 1980
Launched 1 Dec 1982
Commissioned 28 Apr 1984

TIRELESS (S 88)
Builder Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Ordered 5 Jul 1979
Laid down 6 Jun 1981
Launched 17 Mar 1984
Commissioned 5 Oct 1985

TORBAY (S 90)
Builder Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Ordered 26 Jun 1981
Laid down 3 Dec 1982
Launched 8 Mar 1985
Commissioned 7 Feb 1987

TRENCHANT (S 91)
Builder Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Ordered 22 Mar 1983
Laid down 28 Oct 1985
Launched 3 Nov 1986
Commissioned 14 Jan 1989

TALENT (S 92)
Builder Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Ordered 10 Sep 1984
Laid down 13 May 1986
Launched 15 Apr 1988
Commissioned 12 May 1990

TRIUMPH (S 93)
Builder Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Ordered 3 Jan 1986
Laid down 2 Feb 1987
Launched 16 Feb 1991
Commissioned 12 Oct 1991

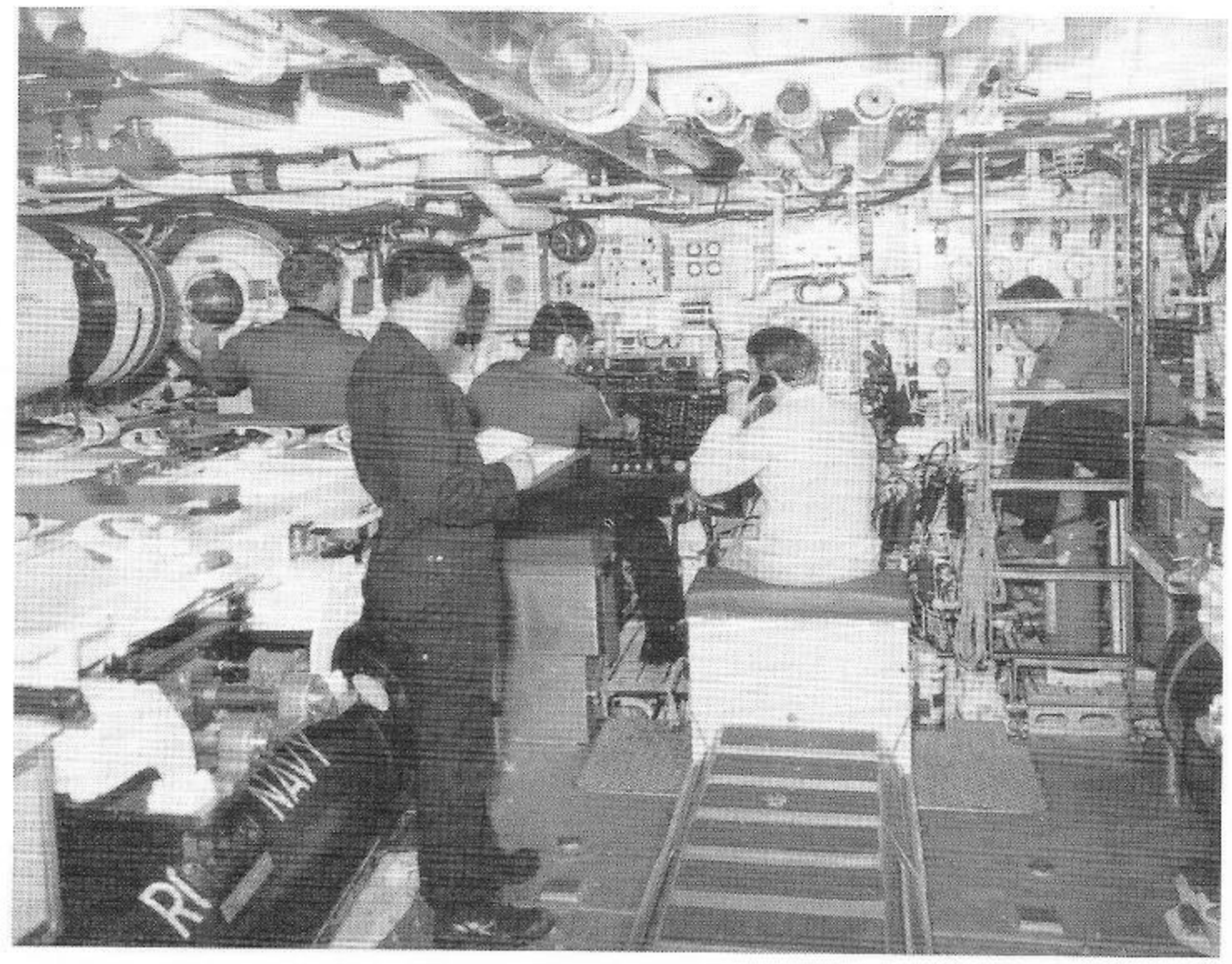
WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas UGM-84B Sub-Harpoon Block 1C

All British SSNs and SSBNs carry Sub-Harpoon anti-ship missiles as part of their weapon load, which are either Block 1B or Block 1C versions. Block 1C has a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications (Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)



Torpedo room in Trafalgar (UK MoD/CINC Fleet)

Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s.
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

Five 533 mm (21 in) tubes.
Total weapons, 25.

TORPEDOES

GEC-Marconi Spearfish

'Swiftsure' class submarines have, during their mid-life refits, been fitted to accommodate and launch the Spearfish torpedo.

Spearfish is a dual-purpose, wire-guided torpedo, designed to counter fast, deep diving, quiet and strong-hulled submarines as well as surface targets, where the acoustic fuzing system detonates the warhead under the hull, creating a whipping effect to break the ship's back. Primary operation is in the passive mode, but with an active mode for use against very quiet targets, or in the final stages of attack, where the powerful transmitters have a long detection range and 'burn through' enemy countermeasures. Target detection capabilities are further enhanced by an array with many times the search volume of Tigerfish, with frequency-agile transducers which enable salvo firing to be carried out.

The torpedo normally operates autonomously, relaying data back to the submarine, but the command team can assume control at any time. The wire is dispensed from two reels, one in the torpedo, the other in the submarine launch tube, using a dispenser which allows discharge at high submarine speeds as well as giving the submarine complete freedom of manoeuvre after launch. Spearfish contains a number of homing and tactics computers to control the weapon, enabling it autonomously to select search detection and attack modes, to classify signal returns, to decide on appropri ate tactics including re-attacks on the target if necessary, and to classify, track and overcome countermeasures and decoys.

Specifications

Length: 7 m (22.96 ft)
Diameter: 533 mm (21 in)
Weight: 1,850 kg (4,078 lb) (in air)
Speed: Approx 65 kts (max)
Range: Active/passive homing to 14 n miles (26 km) at 70 kts; attack speed 55 kts
Warhead: 300 kg (661 lb) blast and shaped (directed-energy) PBX-104 warhead
Engine: Sundstrand 21TP01 gas turbine using Otto fuel

Manufacturer/Contractor

GEC-Marconi Underwater Weapons Systems Ltd, Waterlooville, Hampshire, UK.

GEC-Marconi Mk 24 Mod 2 Tigerfish

Tigerfish uses the passive mode whenever possible, with the interrogation rate being progressively increased as the torpedo nears the target to improve system accuracy. The onboard computer performs several functions during the attack, including interrogation control, sonar data computation, torpedo steering control and data transmission to the submarine to update its computer memory. The onboard computer is connected through the guidance wire to the submarine's torpedo fire-control computer. During the wire-guidance phase the torpedo's computer responds to the demands of the submarine computer, with wire being dispensed from both torpedo and submarine to avoid any stress due to their relative motion. Wire guidance ceases at the point where the torpedo's automatic three-dimensional passive/active acoustic homing system can control the final run to the target and during this phase the torpedo computer interprets data from the homing system sensors to calculate and then command the appropriate course, subject to a priority overriding steer-off azimuth control from the submarine.

Specifications

Length: 6.46 m (21.19 ft)
Diameter: 533 mm (21 in)
Weight: 1,550 kg (3,417 lb) (in air)
Propulsion: Electrically driven contrarotating propellers
Speed: 24 kts (passive), 35 kts (active)
Range: 7.5-22 n miles (13-39 km) (estimated)
Max operating depth: 610 m (2,000 ft) (estimated)
Warhead: Royal Ordnance 134 kg (295 lb) PBXN 105 warhead
Fuze: Dual-action impact (inertia-type) and proximity (magnetic)
Power: 2 Chloride silver/zinc oxide batteries driving a 2-speed electric motor
Propellers: 2, contrarotating

Manufacturer/Contractor

GEC-Marconi Underwater Weapons Systems Ltd, Waterlooville, Hampshire, UK.

Mines

Stonefish mines can be carried in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Racal Outfit UAP (2)

The UAP(2) passive intercept ESM system (formerly UAC(1)) is specifically designed for British SSNs and functions through the search periscope. The system measures the parameters of received radar signals and compares them with a library of parameters. Signal identity, bearing and threat category are displayed in tabular format. Raw data on bearing and frequency are given on a display which can be overlaid with symbols and data derived from the signal analysis processor. Specific intercepts can be analysed in greater depth using a manual pulse analyser. The system incorporates the Racal Sadie signal analysis processor which permits data rates of up to 500,000 pps to be handled with no degradation. Additionally, a fully representative onboard trainer is integrated within the operator's console.

Manufacturer/Contractor

Racal Radar Defence Systems Ltd, Chessington, UK

ELECTRONIC COUNTERMEASURES (ECM)

SSDE Mk 8

Two SSDE (Submarine Signal and Decoy Ejectors) Mk 8. There are two SSDEs, one forward, the other aft, which are used to eject decoys and emergency signal generators.

Manufacturer/Contractor

Strachan & Henshaw, Bristol, UK.

Type 2066

The Type 2066 is a torpedo decoy launched from the SSE.

Manufacturer/Contractor

Dowty,

Type 2071 torpedo decoy

The Sonar Type 2071 (also known as UW300S) is a depth-compensated, low-frequency acoustic projector which transmits complex signals consisting of tones, noise bands or pulses to provide noise countermeasures against sonars and torpedo homing heads. The device consists of a user-programmable digital signal generator (DSG), a power amplifier, hydrosounder with pressure compensator and a test unit.

The DSG is capable of simultaneously generating up to 11 different signals, which may comprise single tones, swept tones, bands of random noise, modulated noise, or pulses. The type, frequency, amplitude and duration of these signals is programmed into the DSG using a keypad and displayed for the operator via a VDU. The DSG is able to store in memory up to eight sets of programs, thus eliminating the need to reprogram each time the system is used. Prerecorded data may also be routed through the DSG.

Manufacturer/Contractor

Gearing & Watson (Electronics) Limited, Hailsham. Eastbourne, UK.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Outfit DCB/DCG

Outfit DCB is a mainframe AIO (Action Information Organisation) system designed to provide a clear tactical picture from all filtered sensor data and can perform target motion analysis (TMA) on up to 24 tracks. It is also designed to assist in the assessment of this tactical picture and to perform various tactical calculations. Outfit DCB has two Ferranti FM1600B computers, each with an operating speed of 200 Kips (thousand instructions per second) and a 700,000 word memory. Coral 66 software language is used, incorporating the KATE (Kalman Analysis and Track Evaluation) algorithm for TMA. The software package on all these systems has received numerous changes both to match enhanced sensor performance and to upgrade the system.

Computer-calculated firing solutions and the tactical picture are shown on one screen and weapon settings on the other. The system is compatible with straight, pattern-running and wire-guided torpedoes as well as Sub-Harpoon missiles and can engage two targets and control two wire-guided torpedoes simultaneously. The system also monitors torpedo tube and weapons states, initialises the weapons before launch and controls the launch sequence through the fire-control console. The weapons interface provides prelaunch data, guidance commands and discharge equipment drive pulses to the appropriate tubes and weapons. Data from the control room is transferred to the weapons compartment digitally on two serial highways with responses on another two serial highways.

Outfit DCG has been added to the system to accept navigational, tactical and sensor data from Outfit DCB and use them to conduct intensive analysis, usually to assist the TMA (target motion analysis) function. Outfit DCG consists of an array processor capable of 8 Mflops (million floating point operations per second) and a 128,000 word mass memory device to hold long timespans of data.

The sonars in British nuclear submarines were developed as stand-alone elements, but a considerable

degree of integration has been achieved through interface units, which federate the different sonar systems, thus enabling data from one to be relayed to another for processing and display.

The system is currently being upgraded by replacing the FM1600B computers with the F2420 which has an operating speed of 1.9 Mips (millions of instructions per second) and a memory of 2.3 million words. This upgrade makes possible integration with the weapon system databus, improved MMI (man/machine interface) and colour displays, an expanded database, improved tracking algorithms and the introduction of command aids. The replacement is carried out within 22 days, which is the length of an assisted maintenance period.

Manufacturer/Contractor
Ferranti-Thomson, Stockport, UK.

RADAR

Specifications
Type 1007
Role: Navigation
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 31 dB
Pulsewidth: 0.08/0.35/0.8 µs
Pulse repetition frequency: 1,600/800/400 pps
Scan rate: 26 rpm

Manufacturer/Contractor
Kelvin Hughes, Ilford, Essex, UK.

SONARS

Type 2007
This long-range passive flank array sonar is installed in all boats except *Triumph* (S 93) and is being replaced by the GEC-Marconi Type 2072. The Type 2007 has three aligned arrays on either side and uses steerable beams. It operates in the 1 to 3 kHz frequency range and is used for initial detection at long range as well as for discovering bearings.

Manufacturer/Contractor
Graseby Marine, Watford, UK.

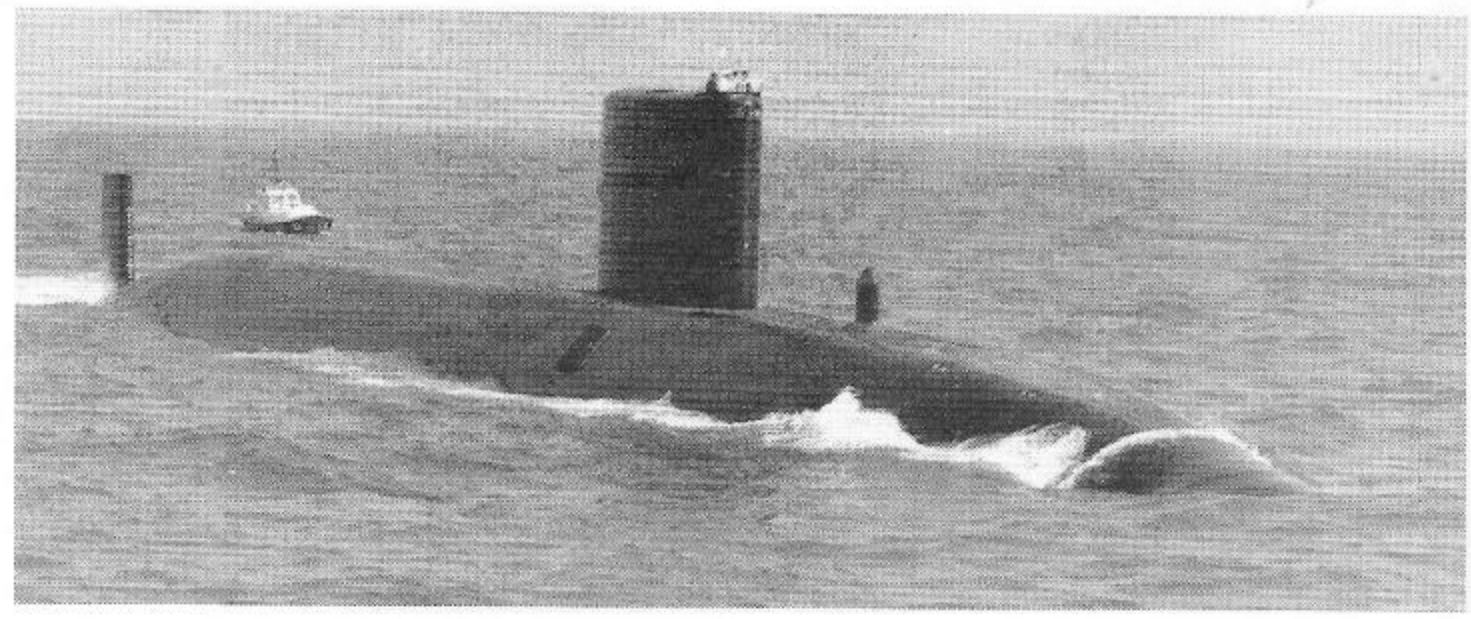
Type 2008
Type 2008 is a high-frequency underwater telephone, which is also used as a short-range passive sonar.

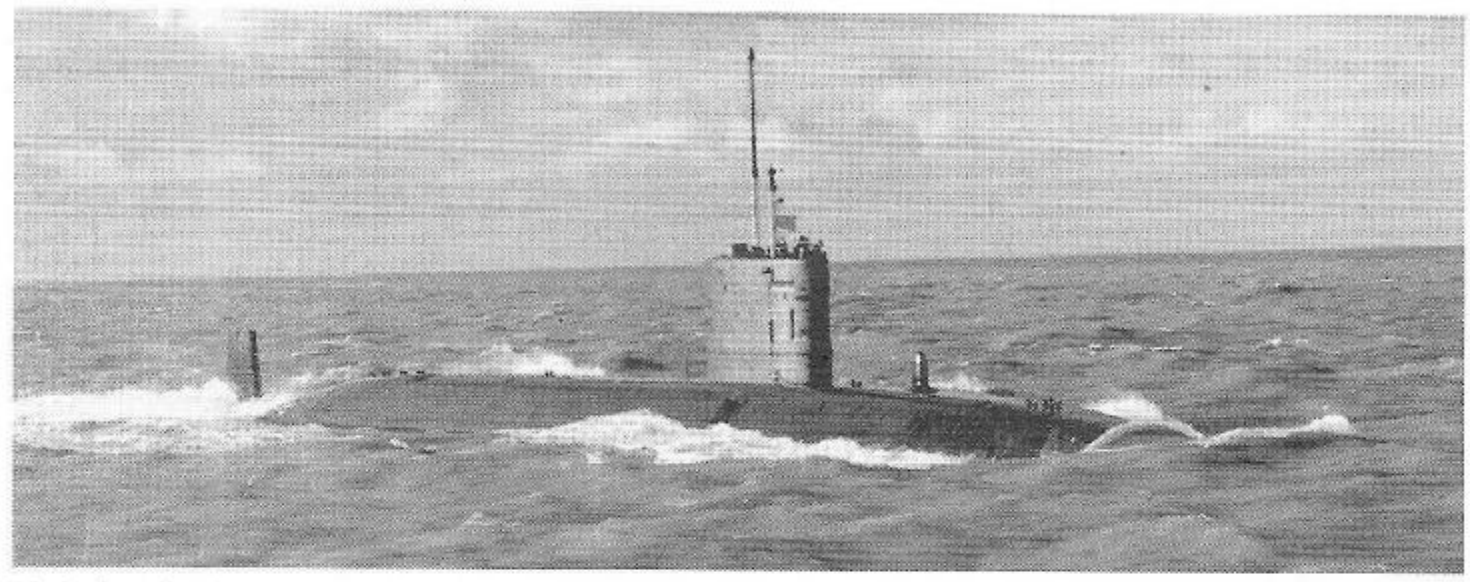
Manufacturer/Contractor
Graseby Marine, Watford, UK.

GEC-Marconi Type 2019
The GEC-Marconi Type 2019, also known as PARIS (Passive Active Range Intercept Sonar), operates in the 1.75 to 14.5 kHz frequency range. It is being replaced by the Type 2082.

Manufacturer/Contractor
GEC-Marconi, Sonar Systems Division, Templecombe, Somerset, UK.

GEC-Marconi Type 2020
Type 2020 is a bow-mounted, active/passive sonar, which has now replaced Type 2001 in most boats. It has a cylindrical array, providing 360° coverage and operating normally in the passive mode between 2 and 16 kHz. It also has an active mode, using automatic beam-steering with manual override, in the low- and medium-frequency bands, reportedly between 3 and 13 kHz.





Turbulent *(top) and* Talent *(below). Note that* Talent *has many of the retractable bollards raised and that it also has extra sensors in the sail* (VSEL)

Manufacturer/Contractor
GEC-Marconi, Sonar Systems Division, Templecombe, Somerset, UK.

GEC-Marconi Type 2026
The GEC-Marconi Type 2026 is a towed, passive array sonar capable of detecting both broad- and narrow-band noise; the system includes sensitive hydrophones, a broadband processor in the low-frequency band and a Curtis architecture processor. Type 2026 was installed in the first five boats, but is being replaced by Type 2046.

Manufacturer/Contractor
GEC-Marconi, Sonar Systems Division, Templecombe, Somerset, UK.

Type 2046
The Ferranti-Thomson Type 2046 is designed for long-range target detection, classification and tracking, this includes a processor-display 'dry end' and a 50 m (164 ft) long 'wet end' (towed array). It operates in the passive mode at very low frequencies. It was installed in *Talent* (S 92) and *Triumph* (S 93) during construction and is being retrofitted in the earlier five boats during their mid-life refits.

Manufacturer/Contractor
Ferranti-Thomson Sonar Systems, Stockport, UK.

GEC-Marconi Type 2072
The GEC-Marconi Type 2072 is a linear, flank array using broadband, passive techniques. It is replacing the Type 2007.

Manufacturer/Contractor
GEC-Marconi, Sonar Systems Division, Templecombe, Somerset, UK.

GEC-Marconi Type 2074
The GEC-Marconi Type 2074 bow-mounted, low-frequency, active/passive search and attack sonar uses the Type 2020 array, which it replaces. Apart from the array, it occupies five times less volume than the equipment it replaces.

Manufacturer/Contractor
GEC-Marconi, Sonar Systems Division, Templecombe, Somerset, UK.

Type 2076
The designation Type 2076 covers the entire suite, comprising Types 2074, 2077 and 2081.

Manufacturer/Contractor
Ferranti-Thomson Sonar Systems, Stockport, UK.

GEC-Marconi Type 2077
The GEC-Marconi Type 2077 is a short-range classification sonar, which is currently in the process of being fitted. It is an active, high-frequency set, used principally for under-ice navigation.

Manufacturer/Contractor
GEC-Marconi, Sonar Systems Division, Templecombe, Somerset, UK.

Type 2082
The Ferranti-Thomson Type 2082 is a passive intercept and ranging sonar, which is replacing the Type 2019 PARIS.

Manufacturer/Contractor
Ferranti-Thomson Sonar Systems, Stockport, UK.

PERISCOPES

The Barr & Stroud periscopes are the CH34 search and CK84 attack types, the latter having dual ×1.5 and ×6 magnification and incorporating a thermal vision TC camera with video recording facilities. The search periscope is used for 35 mm still photography and the mast also supports the antennas for the UAB ESM threat warner and the VHF/ULF broadband communications antenna.

PROPULSION

Specifications
System: Nuclear
Reactor: 1 Rolls-Royce PWR 1
Steam turbines: 2 GEC; 11.2 MW (15,000 hp)
Shafts: 1
Propulsor: 1 pumpjet propulsor
Turbogenerators: 2 W H Allen turbogenerators; 3.2 MW
Diesel alternators: 2 Paxman diesel alternators; 2.09 MW (2,800 hp)
Emergency drive: 1 electric motor and retractable propeller

PROGRAMME

With seven boats built, this is the most numerous class of British SSNs to date. All were built by VSEL between 1979 and 1991 and they replaced the original 'Dreadnought' and 'Valiant' classes.

Trafalgar began a three-year refit in early 1993 and *Turbulent* started a similar refit in October 1993, which was somewhat earlier than scheduled, due to damage incurred in a serious dockyard fire.

DESIGN

The 'Trafalgar' class is essentially an 'improved Swiftsure' design and was designed to be faster and much quieter, as well as having greater endurance. Externally, they appear similar to the 'Swiftsure' class, except for a much taller vertical rudder. Both the pressure hull and all outer surfaces are covered with conformal anechoic noise reduction coatings and there seems to have been a considerable improvement in the method of adhesion, since gaps in the coating where tiles have fallen off are now rarely seen.

The 'Trafalgar' class has the same beam as the preceding class, but is 2.48 m (8.14 ft) longer, and is built of NQ-1 steel, which is equivalent to HY 80. There are three decks divided into four pressure-tight compartments, with escape hatches fore and aft. The forward hydroplanes are retractable and the sail is strengthened for under-ice operations.

There are five torpedo tubes, the same number as the 'Swiftsure' class. In order to avoid the bow-mounted sonar array the four outer tubes are angled slightly outwards and the central tube is angled downwards.

The clip-on towed sonar array is attached to the port aft hydroplane. *Turbulent* carried out trials with a reelable towed array which is housed in a 'hump' mounted on the upper casing some 5 m (16 ft) abaft the sail.

Boats are controllable in the right conditions at speed down to 3 knots on after hydroplanes alone, although the forward hydroplanes are normally extended at speeds below seven knots.

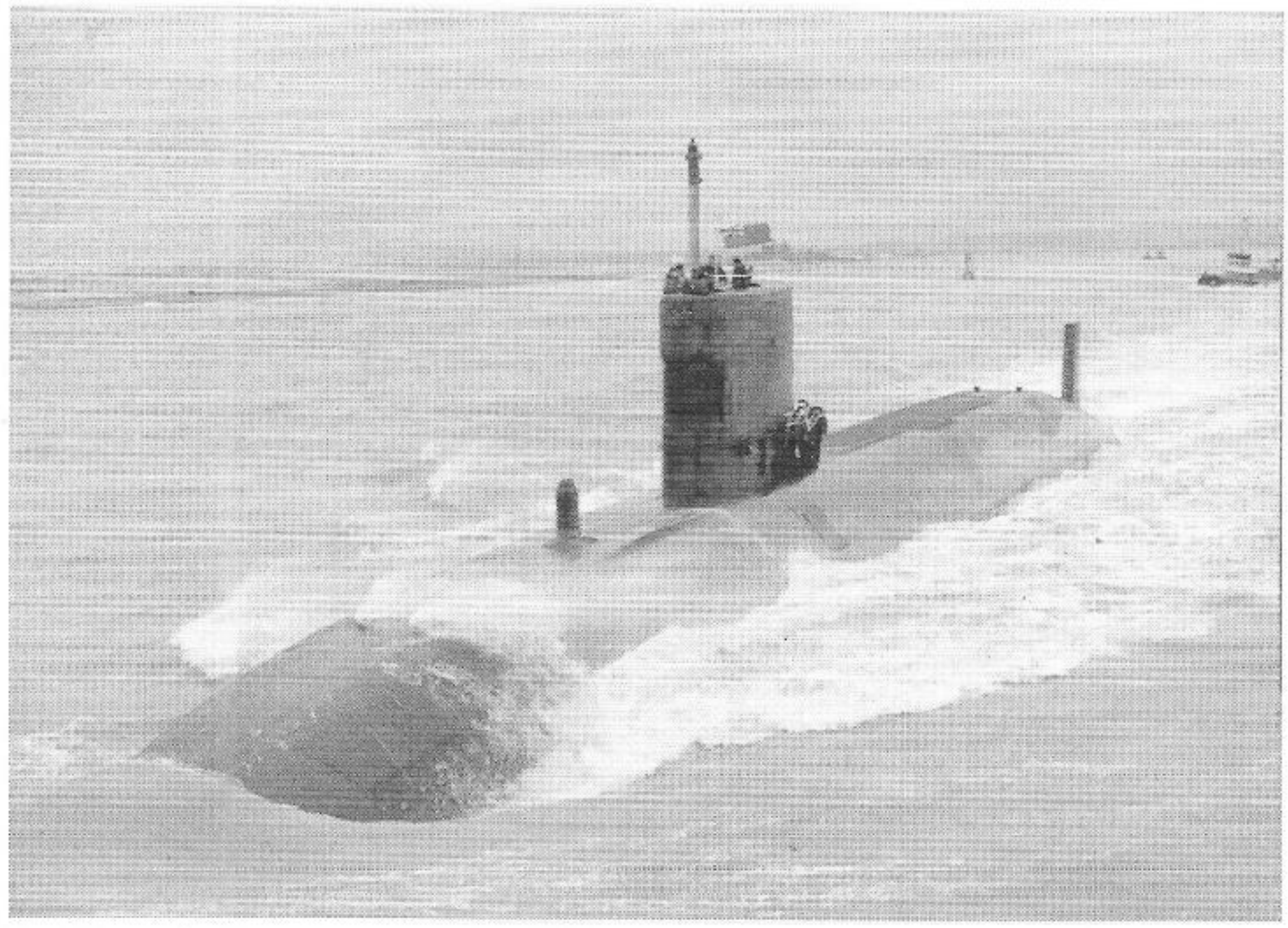
Type 778 and Type 780 echo-sounders are mounted vertically for use in under-ice operations.

MODERNISATION

Modernisation is a continuing process. The Kelvin-Hughes Type 1006 radar is being replaced by the same company's Type 1007. All are being updated with Type 2076 sonar systems, which will be integrated with SMCS and countermeasures. From 1995/96 sonar 2076 starts to replace 2074 and 2046. This update also includes Marconi Type 2077, short-range classification sonar.

Tomahawk cruise missiles will be carried from 1998 onwards.

FURTHER INFORMATION



Triumph *(S 93), the seventh and last of the Batch I 'Trafalgar' class to be built* (VSEL)

OPERATIONAL

In 1989 a typical 'Trafalgar' class operational cycle lasted 17 weeks of which 11 were spent at sea, followed by five on Assisted Maintenance Period (AMP) and one for harbour training. With the ending of the Cold War and the incorporation of more modern and more reliable equipment this cycle may have changed. Also, turnaround times can be considerably reduced and periods at sea increased during crises.

Trafalgar was the trials submarine for Spearfish which started full production in 1992 and was first embarked operationally in *Trenchant* in early 1994.

All of the class belong to the Second Submarine Squadron based at Devonport, the main naval base in southwest England.

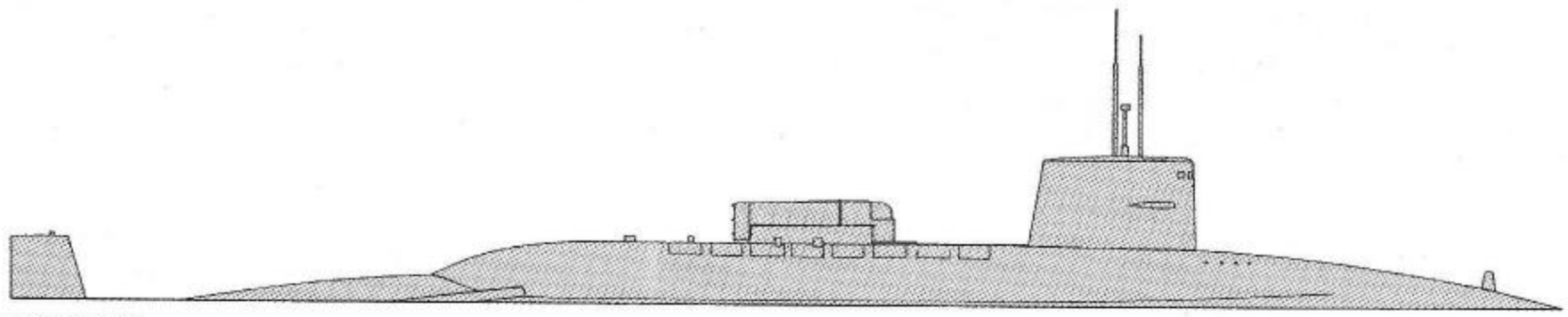
Batch 2 Trafalgar

The next class of British SSNs was originally intended to be an entirely new design, the 'SSN-20' (also known as the 'W' class), which, among other features, would have been powered by a modified version of the PWR-2 used in the 'Vanguard' class SSBNs. By 1990, however, it had become clear that unit cost (not including R&D) would be of the order of £400 million and this, coupled with the rapidly reducing defence budget led to the project being cancelled in 1991.

It has been decided, instead, to produce a design known as the 'Batch 2 Trafalgar' class (frequently abbreviated to 'B2TC'), which implies that the submarines will be straight developments of the original Trafalgars (which, by inference, have now become 'Batch 1 Trafalgars'). Among the few design parameters so far released are that the new SSN will be powered by a derivative of the PWR-2, which will necessitate a hull some 4 m (13.1 ft) longer, and will incorporate all the weapon systems, sensor and command and control improvements going into Batch 1. Other possibilities for Batch 2 include dry dock shelters for special forces, and fully reelable towed arrays.

Invitations to tender for three Batch 2 Trafalgars with an option for two more, were issued by the UK MoD on 14 July 1994 for response by June 1995. There were two bidders: GEC-Marconi, with Amec and Rolls-Royce, and Loral/VSEL, with the former being announced the winner in December 1995. In-service date is still reported to be 2004, which will be some 13 years after the last of the Batch 1s was commissioned. It appears that three will definitely be built, but there is a degree of uncertainty over the other two, not least because unofficial reports suggest that the cost may be close to £1 billion per boat, the bidders' prices having been driven up by the MoD policy that contractors should bear all the financial risks associated with the project.

BENJAMIN FRANKLIN



James K Polk (Ian Sturton)

GENERAL SPECIFICATIONS

Country: USA

Class: BENJAMIN FRANKLIN

Built: 12
Active: 2
Building: 0

Displacement:
surfaced: 7,300 t
submerged: 8,250 t

Dimensions
Length: 129.5 m (425 ft)
Beam: 10.1 m (33 ft)
Draught: 9.6 m (31.5 ft)

Speed, submerged: 25 kts
Diving depth: 225 m (738 ft) approx

Complement: 120 (13 officers) plus 180 troops

SUBMARINES

KAMEHAMEHA (SSN (ex-SSBN) 642)

Builder	Mare Island Naval Shipyard, Portsmouth, New Hampshire, USA
Laid down	2 May 1963
Launched	16 Jan 1965
Commissioned	10 Dec 1965

JAMES K POLK (SSN (ex-SSBN) 645)

Builder	General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down	23 Nov 1963
Launched	22 May 1965
Commissioned	16 Apr 1966

WEAPONS SYSTEMS

TUBES

Four 533 mm (21 in) Mk 65 tubes in bow.
Total tube-launched weapons — 14 Mk 48, or 20 Mk 3.

TORPEDOES

Hughes Mk 48 Torpedo

The Mk 48 torpedo is an anti-submarine and anti-ship torpedo, capable of operating in wire-guided, active or passive, acoustic and non-acoustic modes. The acoustic modes of operation allow active or passive target detection capabilities. The Mk 48 is a long slim cylinder with a flat nose and four fin-like wire stabilisers faired into the afterbody ahead of the shrouded, axial-flow, pumpjet propulsor. From the Mod 3 onwards, the wire-link is two-way, enabling data from the weapon's homing and guidance system to be relayed to the submarine fire-control system, so that the weapon can be guided more accurately from the submarine.

The Mk 48 is designed to operate down to a depth of approximately 760 m (2,500 ft). By adjusting the software, however, the torpedo is capable of operating at depths in excess of 1,000 m (3,500 ft)

Specifications
Mk 48 Mod 4
Length: 5.84 m (19.16 ft)
Diameter: 533 mm (21 in)
Weight: 1,579 kg (3,480 lb)
Max range: 17.4 n miles (32.2 km)
Operating depth: 760 m (2,490 ft)
Max speed: 55 kts
Warhead: 272 kg (600 lb)

Manufacturers/Contractors
Hughes Aircraft Company, Ground Systems Group, Fullerton, California, USA (prime).
Westinghouse Electric Corporation, Baltimore, Maryland, USA (second source).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

WLR-8(V)2

WLR-8(V)2 is a fully digital, solid-state, tactical electronic warfare and surveillance receiver designed specifically for 'Los Angeles' class SSNs, but which has been backfitted into these two submarines. Covering frequencies from 50 MHz to 18 GHz, it provides comprehensive ESM (Electronic Support Measures) facilities and is compatible with NTDS (Navy Tactical Data System). There are two computers: GTE PSP-300 for system control, automatic signal acquisition and analysis, and file processing; and a GTE PSP-200 microcomputer for hardware level control functions. Operational facilities include: automatic measurement of signal direction of arrival; signal classification and recognition; sequential or simultaneous scanning over a wide frequency range; signal activity detection for threat warning; and the analysis of signal parameters (for example, frequency, PRF, modulation, pulsewidth, amplitude and scan rate).

Manufacturer/Contractor
GTE Electronic Defense Systems Sector, Mountain View, California, USA.

WLR-10

The WLR-10 radar warning system shares an antenna with WLR-8.

ELECTRONIC COUNTERMEASURES (ECM)

ADC Mk 2 Mod 1

Eight launchers for ADC (Acoustic Device, Countermeasure) Mk 2 Mod 1 submarine-launched decoys, designed to counter acoustic torpedoes. Launched from a Mk 1 Mod 2 decoy launcher (an 80 mm (3.1 in) diameter tube) the ADC, which looks like a small torpedo, moves to a preselected depth, where it uses its nose-mounted propeller to hover vertically, emitting an acoustic signal.

Manufacturers/Contractors
ESCO Electronics (formerly Emerson Electric Co) (prime).
Hazeltine Corp (an ESCO subsidiary) Greenlawn, New York, USA (current production).

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

FCS Mk 113 Mod 9

These two submarines are the only US submarines to retain the somewhat elderly, analogue Fire Control System (FCS) Mk 113 Mod 9, which has been operational since 1962. The Mk 113 was originally deployed aboard US Navy SSNs and then, with the addition of two Analyzer Console Mk 78, it became the FCS Mk 113 Mod 9 for deployment aboard 'Lafayette' and 'Franklin' class SSBNs. The system controls the preparation, status, launch and guidance of the Mk 48 heavyweight torpedo, the primary defensive ASW weapon aboard these two submarines. A current system refurbishment contract makes provisions for an embedded AN/UYK-44 computer and a new state-of-the-art electronics section for the Analyzer Console Mk 78, which computes TMA (time-motion analysis) data. These modifications will extend the useful life of the Mk 113 Mod 9 system at least to the end of the 1990s.

Manufacturer/Contractor

Loral Librascope Corporation, Glendale, California, USA.

RADAR

BPS-15

BPS-15 is a surface search and navigational radar, with a horn antenna mounted on its own short telescopic mast well forward on the sail.

Specifications

Band: I/J
Beam: 3 × 13°
Peak power: 35 kW
Gain: 29 dB
Pulsewidth: 0.1/0.5 µs
Pulse repetition frequency: 1,500/750 pps
Scan rate: max 9.5 rpm

Manufacturer/Contractor

Sperry Marine, Charlottesville, Virginia, USA.

SONARS

BQR-7

This passive search sonar has been in use since the 1960s and consists of a conformal array of 156 hydrophones, arranged in 52 vertical groups of three around the bow and forward part of the hull. The system covers the 50 Hz to 5 kHz frequency band and is capable of 2° localisation against a snorkelling submarine.

Manufacturer/Contractor

Western Electric, Winston-Salem, North Carolina, USA.

BQR-15

BQR-15 is a passive search, very low-frequency towed array, which was developed for SSBNs to enable them to take advantage of layer 'apertures' to get credible long-range low-frequency/very low-frequency, beam-oriented detection on all contacts. It uses simple technology, with the signals from each hydrophone being fed by twisted pairs to the inboard beamformers. The array is relatively short (approximately 37 m (120 ft)) long, but due to the large number of wires it is relatively fat, with a 9 cm (3.5 in) diameter.

Manufacturer/Contractor

Western Electric, Winston-Salem, North Carolina, USA.

BQR-19 (Tophat)

BQR-19 (also known as 'Tophat') is a short-range, mast-mounted, passive, high-frequency navigational sonar. It was designed for SSBNs to enable them to get 'cross-layer' sooner as the boat comes to periscope depth, and to detect any nearby cavitation noises from surface ships.

Manufacturer/Contractor

Raytheon Company, Submarine Signal Division, Portsmouth, Rhode Island, USA.

BQR-21

BQR-21 is essentially the old BQR-2 array with the addition of DIMUS (Digital Multibeam Steering). It uses a hull-mounted conformal array with preformed beams which are looking everywhere all the time, rather than beam-sweeping through 360° once per minute. It can track up to five targets simultaneously.

Manufacturer/Contractor

Honeywell, West Covina, California, USA.

BQS-4

BQS-4 is an active search and classification sonar, which uses the BQR-21 array for receipt of pulses emitted by an active element consisting of seven vertically stacked transducers. It operates at 7 kHz in the active mode and up to 16 kHz in the passive mode.

Manufacturer/Contractor

Raytheon Company, Submarine Signal Division, Portsmouth, Rhode Island, USA.

PROPULSION

Specifications

System: Nuclear
Reactor: One Westinghouse S5W pressurised water reactor
Turbines: 2 turbines; 11.2 MW (15,000 hp)
Shafts: 1
Auxiliary propulsion: 1 Magnetek auxiliary prop motor; 325 hp (242 kW)

FURTHER INFORMATION

PROGRAMME

These two transport submarines are the last active survivors of the 'Benjamin Franklin' class SSBNs. The original US Navy ballistic missile submarine, the *George Washington,* was created by cutting the hull of the original USS *Scorpion* in two and inserting a missile compartment; it entered service in 1957. This was followed by the remainder of the class, then by the 'Ethan Allen' class and then the 'Lafayette' class, which was officially divided into three groups: Lafayette (SSBN 616) — 9 ships; James Madison (SSBN 627) - 10 ships; and Benjamin Franklin (SSBN 640) — 12 ships.

The 'Lafayette' class as a whole was built to launch 16 Polaris A-1 SLBMs (one warhead; 1,200 n mile range), but were later armed with the Polaris A-2 (one warhead; 1,500 n mile range) and then Polaris A-3 (three MRV warheads, 1,500 n mile range). Most were then converted to take the Poseidon, which carried MIRV warheads and then 12 were later converted to take 16 Trident I (C 5) missiles. In early 1986 one of the class had her missile tubes plugged in order to keep within limits of the SALT agreement and was converted to a 'moored nuclear reactor training submarine' (ARTB). Since then the earlier ships of the class have decommissioned at the rate of two to three per year, a process which rapidly accelerated from 1991 with all Poseidon submarines withdrawn from operational patrols. *Daniel Webster* (ex-SSBN 626) has joined *Sam Rayburn* (ex-SSBN 635) as a second moored training ship.

The US Navy has a tradition dating back to the Second World War of using old submarines as transports for special forces and these two former SSBNs made excellent subjects for conversion as their missile compartment could be removed and the space devoted to troops.

CONVERSION

These two former SSBNs were converted at navy yards — *Kamehameha* (ex-SSBN 642) at Mare Island and *James K Polk* (ex-SSBN 645) at Norfolk — the work being completed in 1994. Both have had their missile installations completely removed, freeing the space for use as accommodation, stores, special forces' weapons rooms and recreation spaces. There are two Dry Deck Shelters mounted side by side on the upper casing, each housing one Swimmer Delivery Vehicle (SDV), as well as a decompression chamber and an access trunk, which enables special forces personnel to enter and leave the shelter while the submarine is submerged.

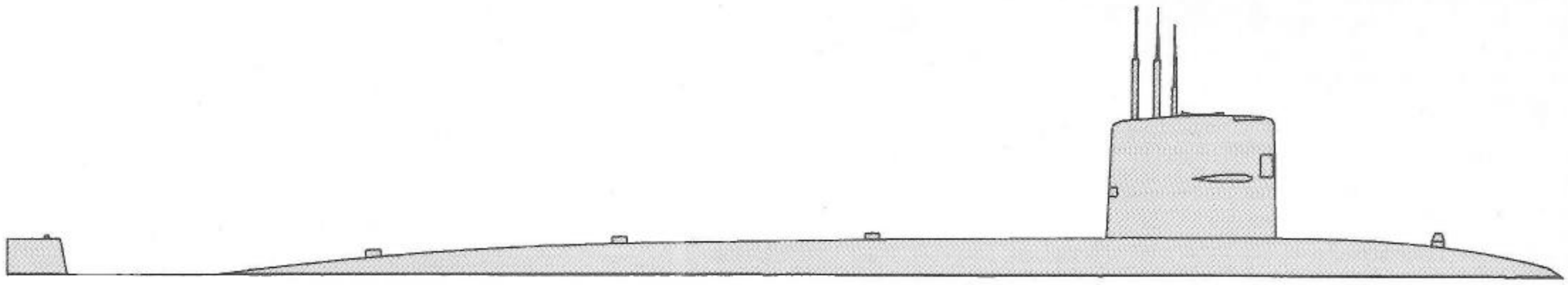
Each submarine has berths for up to 180 troops and SEALs.

Both submarines have been given SSN pennant numbers, but this does not indicate any serious attack capability. Indeed, their sonars and fire control equipment are somewhat dated and their torpedo armament confined to Mk 48 or Mk 37 torpedoes.

OPERATIONAL

These two transport submarines replaced two similarly converted former SSBNs, *John Marshall* and *Sam Houston,* in 1993/94. *Kamehameha* (SSN 642) operates in the Pacific and *James R Polk* (SSN 645) in the Atlantic.

STURGEON



Sturgeon (Ian Sturton)

GENERAL SPECIFICATIONS

Country: USA

Class: STURGEON

Built: 37
Active: 22
Building: 0

Displacement:
surfaced: 4,250 t
submerged: 4,960 t

Dimensions
Length: SSN 637 to SSN 677 89.00 m (292.0 ft); SSN 678 onwards 92.1 m (302.2 ft); SSN 683 122.6 m (402.2 ft)
Beam (all): 9.7 m (31.8 ft)
Draught (all): 8.8 m (28.9 ft)

Speed, submerged: 30 kts
Diving depth: 400 m (1,320 ft)

Complement: 107 (12 officers) plus 79 *(Parche)*

SUBMARINES

TAUTOG (SSN 639)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 27 Jan 1964
Launched 15 Apr 1967
Commissioned 17 Aug 1968

GRAYLING (SSN 646)
Builder Portsmouth Naval Shipyard, Portsmouth, New Hampshire, USA
Laid down 12 May 1964
Launched 22 Jun 1967
Commissioned 11 Oct 1969

POGY (SSN 647)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 4 May 1964
Launched 3 Jun 1967
Commissioned 15 May 1971

SUNFISH (SSN 649)
Builder General Dynamics, Quincy, Massachusetts, USA
Laid down 15 Jan 1965
Launched 14 Oct 1966
Commissioned 15 Mar 1969

PUFFER (SSN 652)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 8 Feb 1965
Launched 30 Mar 1968
Commissioned 9 Aug 1969

SAND LANCE (SSN 660)
Builder Portsmouth Naval Shipyard, Portsmouth, New Hampshire, USA
Laid down 15 Jan 1965
Launched 11 Nov 1969
Commissioned 25 Sep 1971

HAWKBILL (SSN 666)
Builder Mare Island Naval Shipyard, Portsmouth, New Hampshire, USA
Laid down 12 Sep 1966
Launched 12 Apr 1969
Commissioned 4 Feb 1971

BERGALL (SSN 667)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 16 Apr 1966
Launched 17 Feb 1968
Commissioned 13 Jun 1969

SPADEFISH (SSN 668)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 21 Dec 1966
Launched 15 May 1968
Commissioned 14 Aug 1969

FINBACK (SSN 670)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 26 Jun 1967
Launched 7 Dec 1968
Commissioned 4 Feb 1970

PINTADO (SSN 672)
Builder Mare Island Naval Shipyard, Portsmouth, New Hampshire, USA
Laid down 27 Oct 1967
Launched 16 Aug 1969
Commissioned 11 Sep 1971

FLYING FISH (SSN 673)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 30 Jun 1967
Launched 17 May 1969
Commissioned 29 Apr 1970

TREPANG (SSN 674)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 28 Oct 1967
Launched 27 Sep 1969
Commissioned 14 Aug 1970

BLUEFISH (SSN 675)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 13 Mar 1968
Launched 10 Jan 1970
Commissioned 8 Jan 1971

BILLFISH (SSN 676)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 20 Sep 1968
Launched 1 May 1970
Commissioned 12 Mar 1971

ARCHERFISH (SSN 678)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 19 Jun 1969
Launched 16 Jan 1971
Commissioned 17 Dec 1971

WILLIAM H BATES (ex-*Redfish*) (SSN 680)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 4 Aug 1969
Launched 11 Dec 1971
Commissioned 5 May 1973

BATFISH (SSN 681)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 9 Feb 1970
Launched 9 Oct 1971
Commissioned 1 Sep 1972

TUNNY (SSN 682)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 22 May 1970
Launched 10 Jun 1972
Commissioned 26 Jan 1974

PARCHE (SSN 683)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 10 Dec 1970
Launched 13 Jan 1973
Commissioned 17 Aug 1974

CAVALLA (SSN 684)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 4 Jun 1970
Launched 19 Feb 1972
Commissioned 9 Feb 1973

L MENDEL RIVERS (SSN 686)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 26 Jun 1971
Launched 2 Jun 1973
Commissioned 1 Feb 1975

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

BGM-109 Tomahawk

Submarine-launched Tomahawks are in service in three versions. Two versions are for land attack missions: one has a conventional HE warhead (BGM-109C Tomahawk Land Attack Missile-Conventional (TLAM-C)) and the other carries submunitions (BGM-109D Tomahawk Land Attack Missile-D (TLAM-D)). The third type is the BGM-109B Tomahawk Anti-Ship Missile (TASM), which also has a conventional HE warhead. A fourth version, BGM-109A Tomahawk Land Attack Missile-Nuclear (TLAM-N), has been removed from boats at sea as a result of START I, but is retained in reserve ashore and the SSNs could quickly be recertified for TLAM-N in an emergency.

Different missile production standards are referred to by 'Block' numbers. Thus, the majority now in service are Block II, although the Block III has been in production since 1993 and Block II missiles are progressively being brought up to the new standard.

The missile is launched from either a vertical launch tube or from a conventional 533 mm torpedo tube in a capsule and is then driven up towards the surface where it leaves the capsule just before broaching. The rocket booster drives it up into the atmosphere where the turbofan engine takes over and the booster is jettisoned.

Guidance varies between the versions. BGM-109A uses inertial navigation with terrain contour matching (Tercom), while BGM-109B uses inertial plus active radar terminal guidance, and BGM-109C/D inertial and Tercom mid-course guidance with Digital Scene Matching Area Correlation (DSMAC) for terminal guidance. Tercom stores digital terrain profile map information in the missile before launch, which is compared with radar altimeter measurements of ground elevations below the missile during a set number of sections en route to the target. The Block III upgrade programme will include a Global Positioning System (GPS) receiver to supplement or replace the Tercom system. In the terminal phase, DSMAC compares a stored digital representation of the target area with the scene viewed below the missile by a TV camera. This latter system is claimed to be extremely accurate for attacking land targets, with a circular error probable (cep) of 10 m (32.8 ft) being reported. Both the BGM-109C and D versions have a programmable terminal dive attack mode option.

Archerfish *(SSN-678)* (US Navy)

The BGM-109A is fitted with a W80 135 kg (298 lb) nuclear warhead, while the BGM-109B/C have 454 kg (1,000 lb) unitary HE warheads taken from old Bullpup B missiles. The BGM-109D has 166 combined effects BLU-97B bomblets, each weighing 1.5 kg (3.3 lb) which can be dispensed in groups against up to four separate targets.

Block III missiles have a more powerful and more fuel-efficient turbofan engine, which, coupled with increased fuel capacity, results in a range increase of at least 30 per cent. The BGM-109C Block III missiles have a smaller WDU-36B 320 kg (700 lb) warhead carrying a unitary HE charge with a selectable fuze delay to increase warhead penetration before detonation.

During the 1991 Gulf War a total of 264 TLAM-C and 27 TLAM-D were launched against Iraq, of which two submarines fired 15. Reports from the Gulf War, still unconfirmed, suggest that, apart from those with HE warheads, some Tomahawks carried electromagnetic pulse (EMP) generators which were used to disrupt electronic and electrical circuits, while others dispensed lengths of carbon fibre which were used to create short-circuits between overhead electrical power supply cables.

Manufacturers/Contractors

Hughes Missile Systems, Tucson, Arizona, USA (prime).
McDonnell Douglas Missile Systems, St Louis, Missouri, USA (second source).

McDonnell Douglas UGM-84B Sub-Harpoon

All 'Sturgeon' class SSNs carry Sub-Harpoon anti-ship missiles as part of their weapon load, which are either Block 1B or Block 1C versions. Block 1C has a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude

Specifications

Designation	BGM-109B (Note 1)	BGM-109C Block II	BGM-109D Block II	Block III
Mission	Tomahawk anti-ship missile (TASM)	Tomahawk land attack missile - conventional (TLAM-C)	Tomahawk land attack missile - D (TLAM-D)	
Airframe standard	Block II	Block II	Block II	Block III
Length	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)
Diameter	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)
Wing span	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)
Launch weight	1,452 kg (3,201 lb)	1,452 kg (3,201 lb)	1,452 kg (3,201 lb)	n/k
Warheads	454 kg HE (1,000 lb)	454 kg HE (1,000 lb)	166 bomblets	320 kg (705 lb)
Range	240 n miles (450 km)	490-700 n miles (900-1,300 km)	490 n miles (900 km)	690-1,000 n miles (1,285-1,857 km)
Accuracy — circular error probable (cep)	n/a	10 m (33 ft)	10 m (33 ft)	10 m (33 ft)
Speed	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)
In-service date	1983	1983	1989	1993
Engine	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR402 turbofan (335 kg thrust)
Number currently on order	593	1,486	1,157	

Notes
1. BGM-109A (TLAM-N) is not listed as it is not deployed in operational boats, but it should be noted that it remains in reserve ashore.

for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns and, for the terminal phase, have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg (11,907 lb) thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

Four amidships-mounted Mk 63 533 mm (21 in) tubes; hydraulic ram (compressed air-powered) discharge. Total weapon load, 23 weapons; a maximum of 19 torpedoes and four Harpoon, or up to eight Tomahawk in lieu of an equal number of torpedoes/Harpoons.

TORPEDOES

Mk 48 Torpedo

The Mk 48 is an anti-submarine and anti-ship torpedo, capable of operating in wire-guided, active or passive, acoustic and non-acoustic modes. The acoustic modes of operation allow active or passive target detection capabilities. The original Mk 48 was developed in response to a US Navy operational requirement to meet the growing threat posed by Soviet submarines and the November 1960 operational requirement sought a weapon which, compared with the existing Mk 37, would have 400 per cent more range, 100 per cent more speed, 150 per cent increase in diving depth and be able to acquire targets at 17 per cent greater range. The Gould Mk 48 entered production in the early 1970s and an improved version, Mod 3, began deliveries in 1977 but the appearance in November 1978 of the Soviet 'Alfa' class submarines, with a demonstrated speed capability in excess of 40 knots, led to a re-examination of torpedo requirements.

Urgent tests showed that the Mk 48 was more capable than had been thought and modifications were produced to take advantage of the weapon's full capabilities in a programme known as the Mk 48 Mod 4 Near-Term Update (NTU), with first deliveries in December 1980. The longer-term solution was an ADvanced CAPability (ADCAP) and prototypes first ran in 1982 with the type entering production in 1989 as the Mk 48 ADCAP. In May 1988 Westinghouse won a second source contract.

Externally the Mk 48 is a long slim cylinder with a flat nose and four, fin-like dynamic stabilisers, one of which also houses the wire dispensers; these are faired into the afterbody ahead of the shrouded, axial-flow, pump-jet propulsor. From the Mod 3 onwards, the wire-link is two-way, enabling data from the weapon's homing and guidance system to be relayed to the submarine fire-control system, so that the weapon can be guided more accurately from the submarine.

The major feature of the Mk 48 ADCAP is the dramatic improvement in its resistance to countermeasures and there is a totally new nose housing the acoustics and beam-forming circuits, together with a new signal processing system using the latest electronics, a Litton/Singer inertial measurement unit and computers programmed in CMS-2 software. Warhead sensor electronics have also been improved by Loral. The Hughes command control element has been improved to meet the expanding operating envelope (greater depth, target speed and weapon speed options) and improved surface target capabilities. The fuel tank and afterbody sections, produced by Argo-Tech, have been modified for increased fuel delivery rate and greater capacity for improved speed and endurance.

Specifications

	Mk 48 Mod 4	Mk 48 ADCAP
Length	5.84 m (19.16 ft)	5.84 m (19.16 ft)
Diameter	533 mm (21 in)	533 mm (21 in)
Weight	1,579 kg (3,480 lb)	1,587 kg (3,500 lb)
Max speed	55 kts	55 kts
Max range	17.4 n mile (32.2 km)	24.5 n miles (45.75 km)
Max depth	760 m (2,490 ft)	900 m (2,950 ft)
Warhead	272 kg (600 lb)	267 kg (589 lb)

Manufacturers/Contractors

Hughes Aircraft Company, Ground Systems Group (prime).
Westinghouse Electric Corporation (second source).

MINES

Mk 67 Mobile and Mk 60 CAPTOR mines can be carried in place of an equivalent number of torpedoes.

Mk 60 CAPTOR mine

CAPTOR (a contraction of 'en*cap*sulated *tor*pedo') is an anti-submarine mine, which can be laid by aircraft, surface ships or any submarine equipped with standard 533 mm (21 in) torpedo tubes. It consists of a Mk 46 Mod 4 torpedo inserted into a mine casing and is intended to be deployed in deep water, on or near strategic routes travelled by enemy submarines. The detection and control unit (DCU) is gated to ignore surface traffic, but has no IFF capability, which means that friendly units must be warned of CAPTOR minelaying and positions of deployed mines.

Specifications

Length: 3.7 m (overall)
Diameter: 533 mm (21 mm)
Weight: 908 kg (2,000 lb) (incl torpedo and mooring)
Laying depth: Down to approx 300 m (1,000 ft)
Warhead: 43.5 kg (96 lb) PBX-N-103 HE
Range: 1,000 m (1,100 yd)

Manufacturer/Contractor

Loral Systems Group, Akron, Ohio, USA.

Mk 67 SLMM (Submarine-Launched Mobile Mine)

The Mk 67 SLMM is intended to enable US submarines to lay a shallow-water (to approximately 100 m) minefield. The basic element is a converted Mk 37 Mod 2 torpedo, which is launched from a conventional 533 mm (21 in) torpedo tube and then propels itself to the target area, where the engine is switched off and the device sinks to the bottom. This technique enables the submarine to lay a minefield in an area which is navigationally inaccessible or where covert mining is required for tactical (or even political) reasons.

Specifications

Length: 4.09 m (13.4 ft)
Diameter: 485 mm
Weight: 754 kg (1,662.6 lb)
Warhead: 234 kg (516 lb) PBX-N-103 HE
Max depth: 100 m (328 ft)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

WLQ-4

WLQ-4 (also known as Sea Nymph) is a COMINT/SIGINT system which was developed specifically for the 'Sturgeon' class. Very little has been published about its role and performance, but it is reported to be capable of capturing and demodulating any electromagnetic or radio frequency (EM/RF) signal from extremely low frequency (ELF) to the visible spectrum.

Manufacturer/Contractor

GTE Government Systems Corp, Needham Heights, Maryland, USA.

DECOYS

ADC Mk 2 Mod 1

The ADC (Acoustic Device, Countermeasure) Mk 2 Mod 1 is a submarine-launched decoy designed to counter acoustic torpedoes. Launched from an 80 mm (3.1 in) diameter tube, the device, which looks like a small torpedo, moves to a preselected depth, where it uses its nose-mounted propeller to hover vertically, emitting an acoustic signal.

Manufacturers/Contractors

ESCO Electronics (formerly Emerson Electric Co) (prime).
Hazeltine Corp (an ESCO subsidiary) Greenlawn, New York, USA (current production).

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

CCS Mk 1

As of 1996, CCS Mk 1 was fitted in the following: SSN 638-639, 646, 648, 650, 652, 662, 663, 667, 668, 669, 670, 673, 675, 677, 680-685.

Mk 117 Mod 2/3 FCS

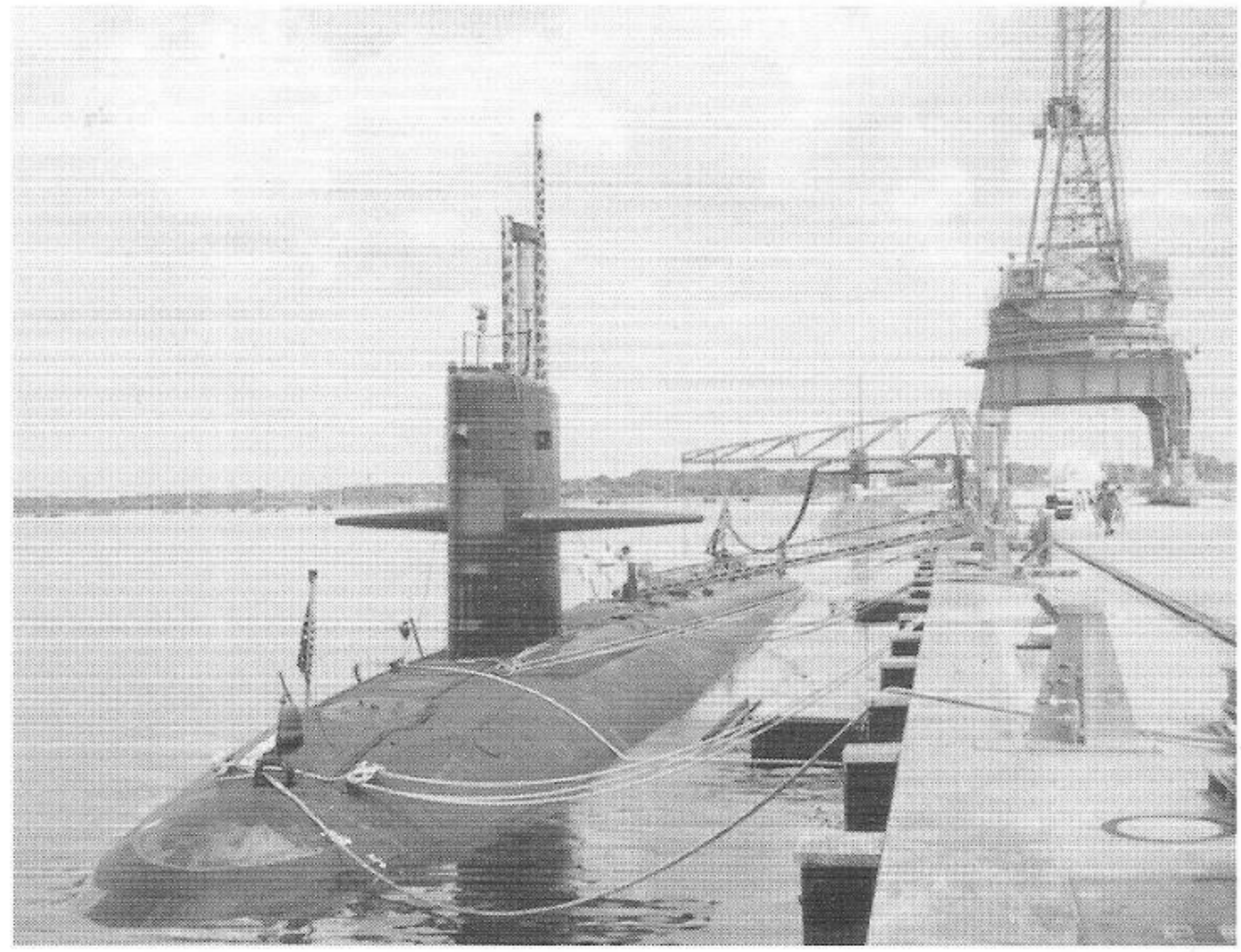
Mk 117 Mods 2 and 3 FCS (fire-control systems) are fitted in the 'Sturgeon' class as follows:

Mk 117 Mod 2: SSN 647, 649, 660, 666, 672, 674 and 676 (used in stand-alone configuration with AN/BQQ-5 B/C/D sonar)

Mk 117 Mod 3: SSN 678 (in stand-alone configuration and AN/BQQ-5B/D sonar)

The Mk 117 FCS is a mainframe architecture system based upon a two-bay UYK-7 computer using software written in C and CMS-2 languages. There are three Mk

81 Mod 1/2 Weapon Control Consoles (WCC) and one Mk 92 Mod 0/2 multipurpose console to which is added a Mk 82 weapon data converter to act as an Attack Control Console (ACC). The WCCs are used for target tracking, TMA, attack evaluation, calculating ballistic solutions and calculating presetting instructions for the weapons. The ACC includes the firing panel and monitors the weapons status and presets the weapons. The Mk 117 is usually associated with the IBM AN/BQQ-5 digital multibeam system which uses hull-mounted and towed array sonars with data processed by a dedicated UYK-7 which then communicates this data to the UYK-7 associated with the fire-control system. The hull-mounted elements consist of bow-mounted active/passive spherical array subsystems based upon the BQS-13 DNA (Digital multibeam Narrowband accelerated Active search) sonar set and a bow-mounted passive conformal array subsystem based upon the BQR-7 sonar. The BQQ-5 features include DIMUS (Digital Multibeam Steering), passive classification, online performance monitoring and improved displays. Ice and mine detection is provided through the Hazeltine AN/BQS-14 or BQS-15 sonars, although they are not integrated into the BQQ-5.



L Mendel Rivers *(SSN-686), one of a small number of nuclear-propelled submarines named (at the time of launching) after living Congressmen. Note the port-side duct for the towed array* (US Navy)

RADARS

BPS-14

BPS-14 was the original surface search and navigation radar fitted in the 'Sturgeon' class and is still to be found in some of the older boats. It is mounted on a telescopic mast, which is installed well forward on the top of the sail. It operates in the I/J-band.

BPS-15

BPS-15 has replaced BPS-14 in most 'Sturgeon' class SSNs. It is a surface search and navigational radar, with a horn antenna mounted well forward on the sail.

Specifications

Band: I/J
Beam: 3 × 13°
Peak power: 35 kW
Gain: 29 dB
Pulsewidth: 0.1/0.5 µs
Pulse repetition frequency: 1,500/750 pps
Scan rate: max 9.5 rpm

Manufacturer/Contractor

Sperry Marine, Charlottesville, Virginia, USA.

SONARS

BQQ-2

The original SSN 638 to SSN 677 are fitted with the Raytheon BQQ-2 sonar suite, which consists of the BQS-6 4.6 m (15 ft) spherical transducer array and the BQR-7 conformal bow array. BQS-6 operates at about 3.5 kHz in active mode and at 500-5,000 Hz in passive mode.

Manufacturer/Contractor

Raytheon Company, Submarine Signal Division, Portsmouth, Rhode Island, USA.

BQQ-5

SSN 678 onwards are fitted with the IBM BQQ-5 sonar suite, which includes the BQS-14A ice-avoidance sonar, TB-16 towed array and the BQR-23 signal processor.

Manufacturer/Contractor

IBM Federal Systems, USA.

BQS-14A

BQS-14A is the primary sonar used for under-ice navigation and detection. It is an integral part of the BQQ-5 system. An active system, the array consists of a set of three fixed staves, each of three transducers, mounted in the lower front of the sail. It operates in the sonar high-frequency band. Some earlier boats in the class may still be fitted with the EDO BQS-8. Since the bow screens a large area, the commander will normally steer a sinuous course and maintain the submarine at as great a 'down angle' as possible, typically about 3.5°.

Manufacturer/Contractor

Raytheon Company, Submarine Signal Division, Portsmouth, Rhode Island, USA.

PROPULSION

Specifications

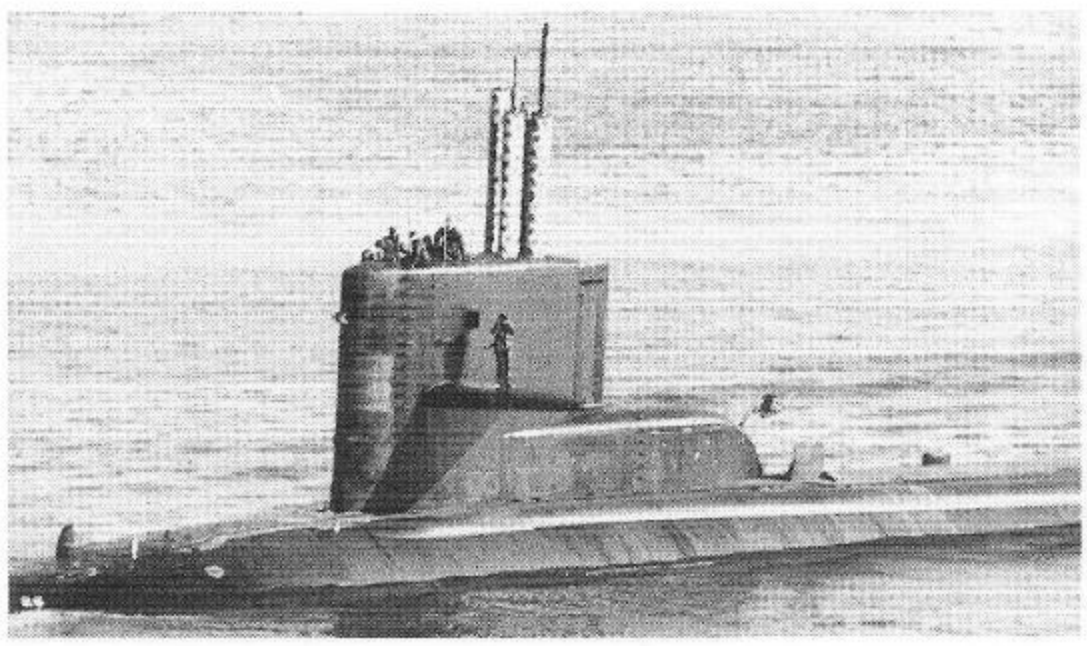
System: Nuclear
Reactor: 1 Westinghouse S5W pressurised water reactor (PWR)
Steam turbines: 2; 11.2 MW (15,000 hp)
Shafts: 1
Propeller: 1, 7-bladed, skew-back

FURTHER INFORMATION

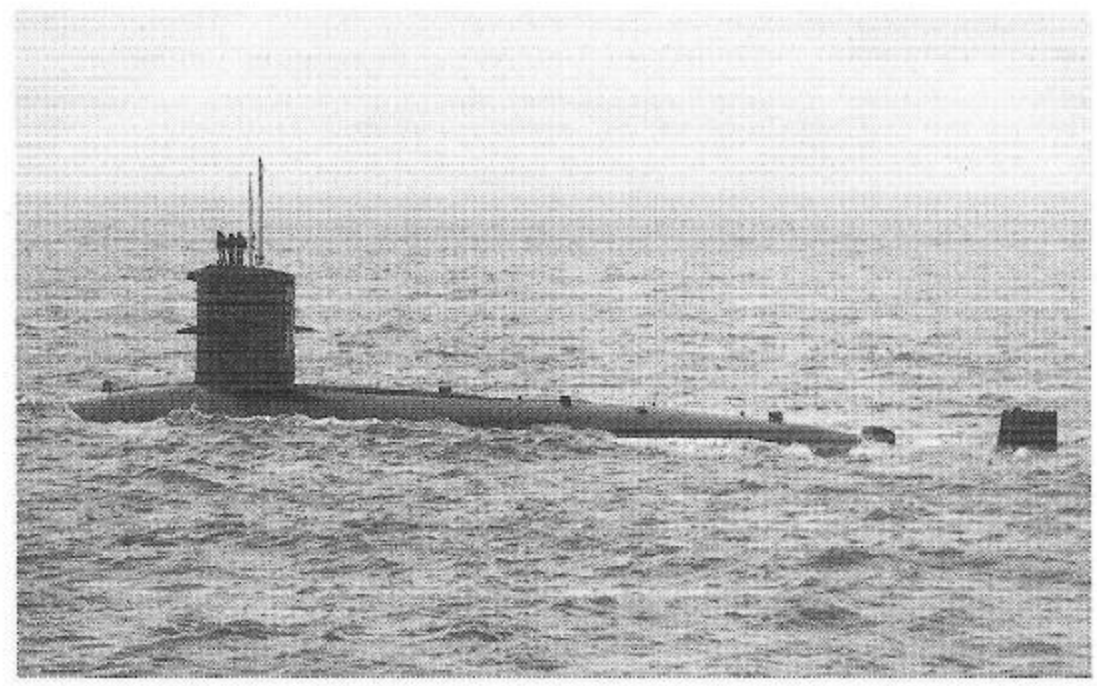
PROGRAMME

The successor to the 'Permit' class, 37 'Sturgeon' class SSNs were built between 1964 and 1975 and several problems arose during the building of the class. *Pogy* (SSN 647) was reallocated to another yard for completion, while *Guitarro* (SSN 665) was delayed for more than two years after sinking in some 10 m (35 ft) of water while being fitted out, an incident later described by a Congressional committee as 'totally avoidable.'

Subroc was phased out in 1990 despite Congressional opposition and nuclear warheads are no longer carried as a result of agreements with Russia.



Silversides *(SSN-679) fitted with a sail extension, one of many experimental installations in the 'Sturgeon' class* (H & L van Ginderen Collection)



Billfish *(SSN-676)* (H & L van Ginderen Collection)

DESIGN

The 'Sturgeon' class was the slightly larger and much improved successor to the 'Permit' class. The Sturgeons have an elongated tear-drop hull with torpedoes set amidships so that the bow can accommodate the various components of the BQQ-2 sonar system.

The sail is particularly high, the top being 6.25 m (20.5 ft) above the deck. The diving planes are mounted on the sail and rotate to the vertical for breaking through ice when surfacing in arctic regions.

SSN 678-684, 686 and 687 were built 3.05 m (10 ft) longer than remainder of class, not, as is sometimes supposed, to accommodate the BQQ-5 sonar and its associated electronic gear, but to improve habitability and to provide space and weight reserves for future developments.

Acoustic tiles are fitted to reduce target strength (the submarine equivalent of 'radar cross-section') and also have a beneficial secondary effect of mitigating the platform's own radiated noise.

Conversions

There have been more than the usual numbers of conversions to boats of this class, some of which are:

Archerfish (SSN 678), *Tunny* (SSN 682), *Cavalla* (SSN 684) and *L Mendel Rivers* (SSN 686) have been converted to enable them to transport special forces. This involves mounting a dry-dock shelter for either an SDV Mk VIII (swimmer delivery vehicle), or inflatable boats, or a platoon of SEALs.

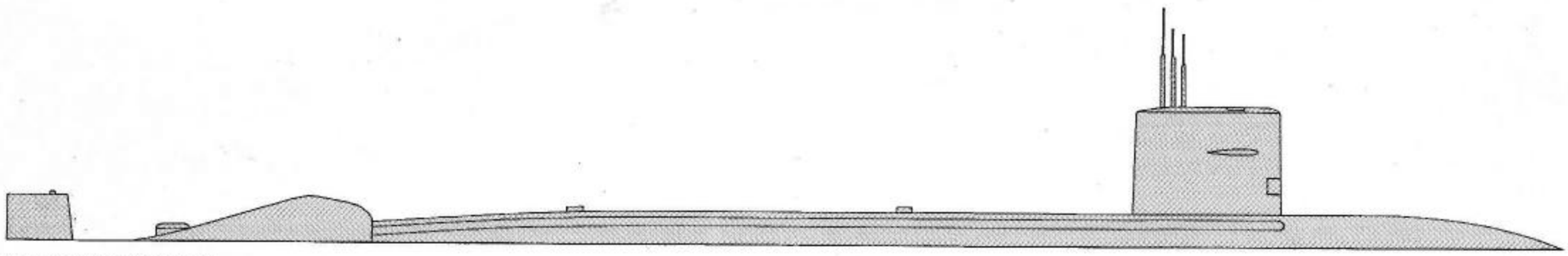
Hawkbill (SSN 666), *Pintado* (SSN 672), *Billfish* (SSN 676), *William H Bates* (SSN 680) (and probably more) have been modified to carry and support the navy's Deep Submergence Rescue Vehicles (DSRV).

Parche has been lengthened by 30.5 m (100 ft) to enable it to accommodate special equipment designed for seabed operations. In addition, the sail-mounted hydroplanes have been moved higher up and there is a noticeable hump in the casing forward of the sail for a cable reel.

OPERATIONAL

These boats were built for an operational life of some 30 years but many have been decommissioned early as a result of defence cutbacks, and more will follow. *Pargo* (SSN 650) undertook an arctic scientific cruise in 1993 and *Cavalla* (SSN 684) carried out a scientific voyage in 1995 to check radiation levels and other oceanographic changes.

NARWHAL



Narwhal (Ian Sturton)

GENERAL SPECIFICATIONS

Country: USA

Class: NARWHAL

Built: 1
Active: 1
Building: 0

Displacement:
surfaced: 5,284 t
submerged: 5,830 t

Dimensions
Length: 95.9 m (314.6 ft)
Beam: 11.5 m (37.7 ft)
Draught: 8.2 m (27 ft)

Speed: 20 kts surfaced; 25 kts dived

Complement: 129 (13 officers)

SUBMARINES

NARWHAL (SSN 671)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA

Laid down 17 Jan 1966
Launched 9 Sep 1967
Commissioned 12 Jul 1969

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

BGM-109 Tomahawk

Narwhal normally embarks the BGM-109B Tomahawk Anti-Ship Missile (TASM) with a conventional HE warhead, although other types can also be launched. The missile is launched from a conventional 533 mm torpedo tube in a capsule and is then driven up towards the surface, where it leaves the capsule just before broaching. The rocket booster drives it up into the atmosphere where the turbojet engine takes over and the booster is jettisoned. BGM-109B uses inertial plus active radar terminal guidance, and is fitted with a 454 kg (1,000 lb) unitary HE warhead.

Specifications

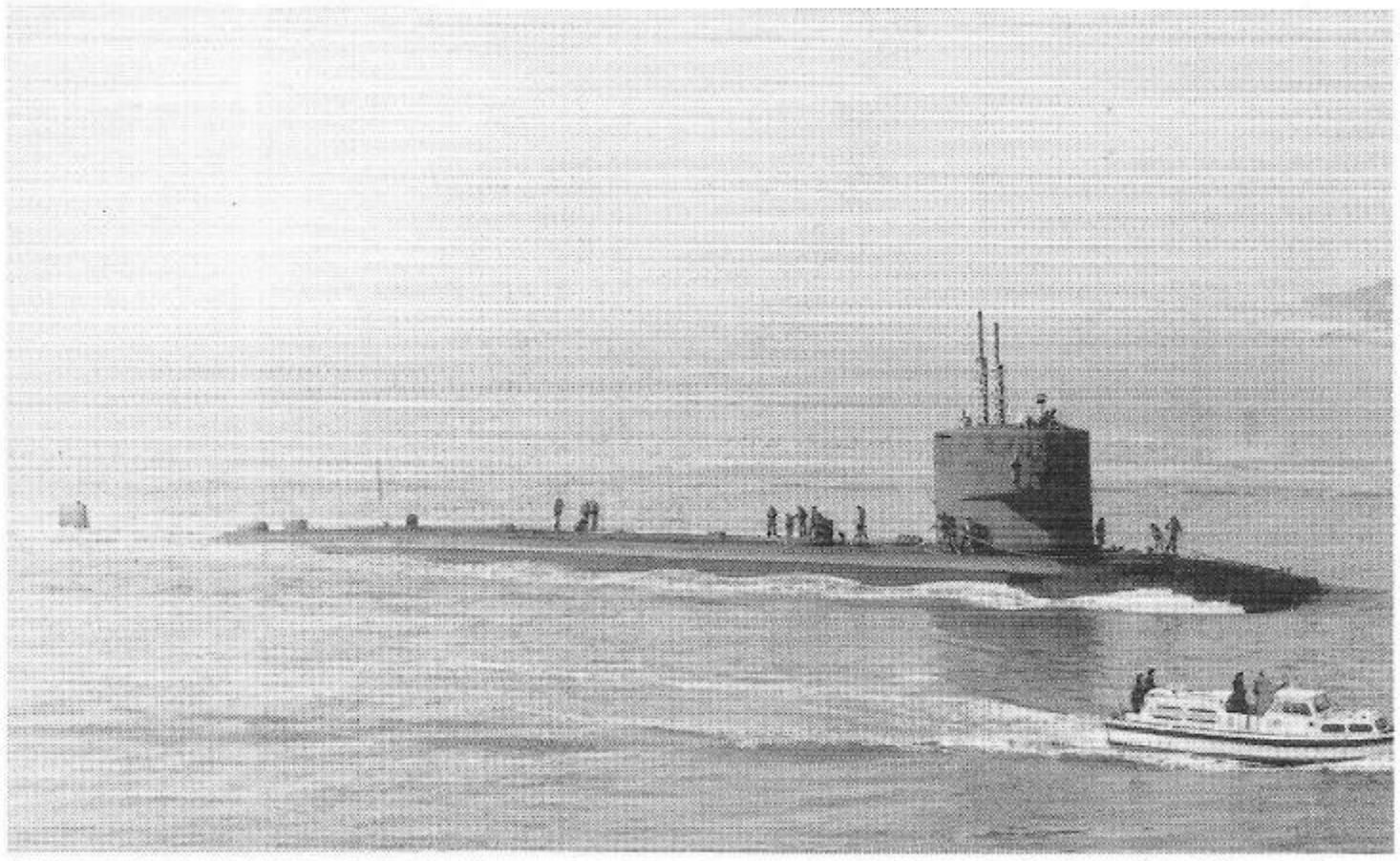
Designation: BGM-109B
Airframe standard: Block II
Length: 6.25 m (20.50 ft)
Diameter: 0.52 m (1.71 ft)
Wing span: 2.65 m (8.70 ft)
Launch weight: 1,452 kg (3,201 lb)
Warheads: 454 kg HE (1,000 lb)
Range: 240 n miles (450 km)
Speed: Mach 0.7 (550 mph)
In-service date: 1983
Engine: Williams International F107-WR400 turbofan (272 kg thrust)

Manufacturers/Contractors

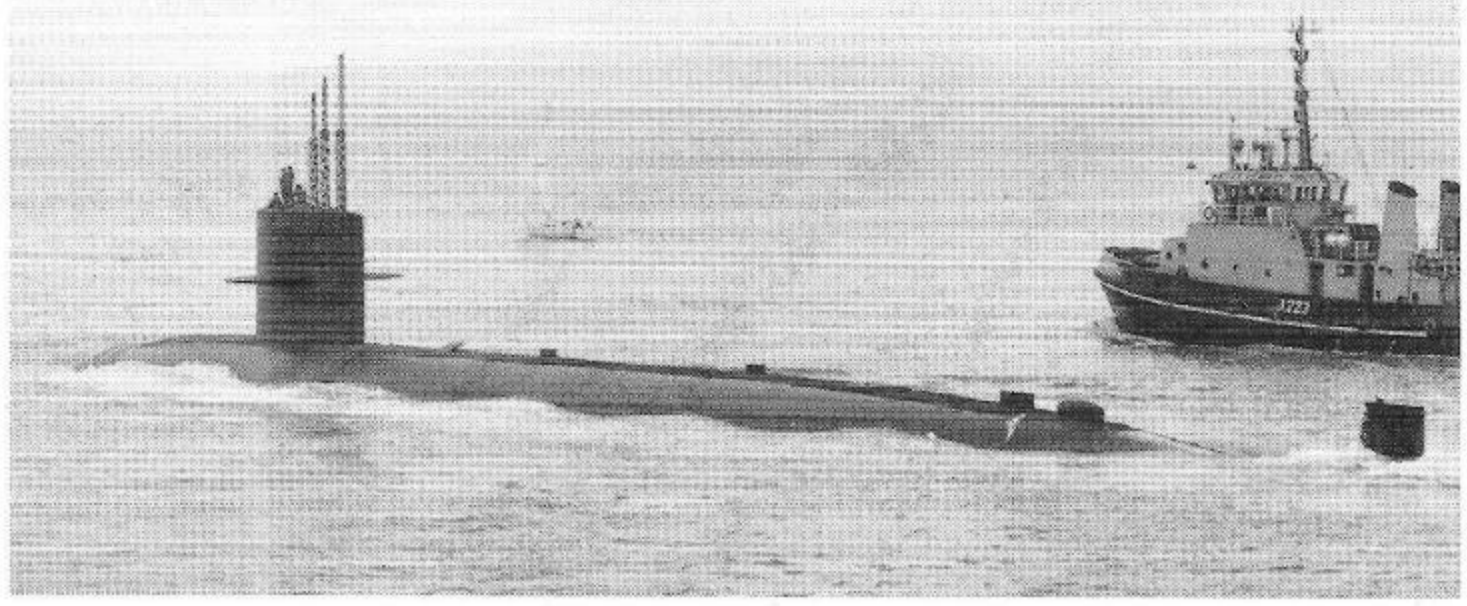
Hughes Missile Systems, Tucson, Arizona, USA (prime).
McDonnell Douglas Missile Systems, St Louis, Missouri (second source).
Williams International, Walled Lake, Michigan, USA (engine).

McDonnell Douglas UGM-84B Sub-Harpoon

Narwhal is fitted to carry and launch Sub-Harpoon anti-ship missiles as part of its weapon load, which are either Block 1B or Block 1C versions. Block 1C has a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal



Narwhal *(SSN 671) in 1971. This submarine is powered by a General Electric S5G natural circulation reactor, but remains the only SSN to have such a system* (H & L van Ginderen Collection)



Narwhal *showing a variety of unusual domes on the rear casing* (H & L van Ginderen Collection)

phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

Block 1C
Length:
with booster: 4.63 m (15.19 ft)
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Guidance: Inertial and active radar

Manufacturers/Contractors

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Thiokol, Elkton, Maryland, USA (booster).

TUBES

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Total weapon load, 23 weapons; maximum of 19 torpedoes, four Harpoon, or up to eight Tomahawk in lieu of an equal number of torpedoes/Harpoons.

TORPEDOES

Mk 48 Torpedo

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Manufacturers/Contractors

Hughes Aircraft Company, Ground Systems Group (prime).
Westinghouse Electric Corporation (second source).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

WLQ-4

WLQ-4 (also known as Sea Nymph) is a SIGINT system which was developed specifically for the 'Sturgeon' class. Very little has been published about its role and equipment, but presumably WLQ-4 is used for electronic reconnaissance/surveillance.

Manufacturer/Contractor

GTE-Sylvania, Needham Heights, Maine, USA.

DECOYS

ADC Mk 2 Mod 1

The ADC (Acoustic Device, Countermeasure) Mk 2 Mod 1 is a submarine-launched decoy designed to counter acoustic torpedoes. Launched from a Mk 1 Mod 2 decoy launcher (an 80 mm (3.1 in) diameter tube) the ADC, which looks like a small torpedo, moves to a preselected depth, where it uses its nose-mounted propeller to hover vertically, emitting an acoustic signal.

Manufacturers/Contractors

ESCO Electronics (formerly Emerson Electric Co) (prime).
Hazeltine Corp (an ESCO subsidiary) Greenlawn, New York, USA.
Emerson Electric Mk 2; torpedo decoy launchers.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS

WSC-3 satellite communications transceiver.

WEAPONS CONTROL

Mk 117 FCS

Narwhal was the first recipient of the Mk 117, which was the first all-digital submarine FCS. It is a mainframe architecture system based upon a two-bay UYK-7 computer using software written in C and CMS-2 languages. There are three Mk 81 Mod 1/2 Weapon Control Consoles (WCC) and one Mk 92 Mod 0/2 multipurpose console to which is added a Mk 82 weapon data converter to act as an Attack Control Console (ACC). The WCCs are used for target tracking, TMA, attack evaluation, calculating ballistic solutions and calculating presetting instructions for the weapons. The ACC includes the firing panel and monitors the weapons status and presets the weapons. The Mk 117 is associated with the *Narwhal's* IBM AN/BQQ-5D digital, multibeam system which uses hull-mounted and towed array sonars with data processed by a dedicated UYK-7 which then communicates this data to the UYK-7 associated with the fire-control system. The hull-mounted elements consist of a bow-mounted active/passive spherical array subsystem and a bow-mounted passive conformal array subsystem. The BQQ-5 features include DIMUS (Digital Multibeam Steering), passive classification, online performance monitoring and improved displays. Ice and mine detection is provided through the Hazeltine AN/BQS-14 or BQS-15 sonars, although they are not integrated into the BQQ-5.

RADAR

BPS-15

BPS-15 is a surface search and navigational radar, with a horn antenna mounted well forward on the sail.

Specifications

Band: I/J
Beam: 3 × 13°
Peak power: 35 kW
Gain: 29 dB
Pulsewidth: 0.1/0.5 µs
Pulse repetition frequency: 1,500/750 pps
Scan rate: Max 9.5 rpm

Manufacturer/Contractor

Sperry Marine, Charlottesville, Virginia, USA.

SONARS

BQQ-5

Narwhal was built with BQQ-2, but this was later replaced by BQQ-5D. Other elements of the suite include the BQS-14A ice-avoidance sonar, the TB-23 towed array and the BQR-23 signal processor.

Manufacturer/Contractor

IBM Federal Systems Division, USA.

BQS-8

Despite other equipment having been updated, *Narwhal* is still fitted with the older BQS-8 ice-detection sonar.

Manufacturer/Contractor

EDO, Government Systems Division, College Point, New York, USA.

TB-23

TB-23 is a towed, very low-frequency passive array, which is designed to be reeled into the boat's main ballast tank.

Manufacturer/Contractor

Bendix Oceanics, Sylmar, California, USA.

PROPULSION

Specifications

System: Nuclear
Reactors: 1 General Electric S5G pressurised water reactor (see Design (on next page))
Steam turbines: 2; 12.7 MW (17,000 hp)
Shafts: 1

FURTHER INFORMATION

PROGRAMME

In the late 1960s and early 1970s the US Navy examined several different methods of propulsion in an effort to seek a much quieter platform for the anticipated battles against Soviet submarines. Rather than build specialised trials submarines, the new propulsion systems were built into contemporary operational designs which enabled direct comparisons to be made. The first of these was *Jack* (SSN-605), one of the 'Thresher' class, which had contrarotating propellers, while another was the *Glenard P Lipscomb* (SSN 685), which had turbo-electric drive. Both had long operational lives, but were eventually stricken in 1989/90, and the systems they trialled have not been repeated.

The third of these propulsion prototypes, *Narwhal*, was authorised in the FY64 building programme, commissioned in 1969, and is still in service, being likely to serve on until the end of the decade.

DESIGN

Narwhal is similar to the 'Sturgeon' class submarines in hull design but slightly larger in order to accommodate the prototype General Electric S5G natural circulation reactor plant. The natural circulation reactor uses the basic principle of convection and thus does away with one of the major sources of submarine noise, the pumps. It was stated at the time of the launch that this new system '...offer(ed) promise of increased reactor plant reliability, simplicity, and noise reduction due to the elimination of the need for large reactor coolant pumps and associated electrical and control equipment, by taking maximum advantage of natural convection to circulate the reactor coolant.'

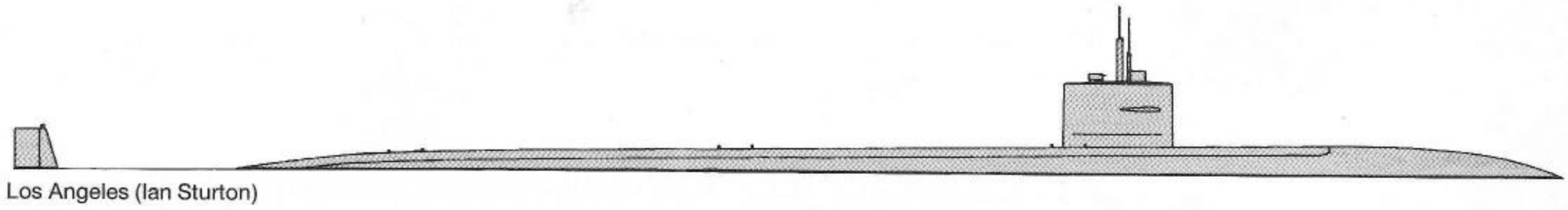
Narwhal has been in service for some 27 years and the 'Ohio' class SSBNs are powered by the S8G reactor, which also uses the natural circulation principle, so the experiment has clearly been a success. No further SSNs have used such a power plant, however, possibly because maximum speed and acceleration are not as great as with a system using pumps.

Narwhal has a prominent 'hump' on the after casing near the stern, which contains a prototype towed communications buoy.

OPERATIONAL

Despite the early retirement of 'Sturgeon' and 'Los Angeles' class SSNs, the 'one-off' *Narwhal* will remain in service until the late 1990s, thus being one of the few to achieve its full 30-year life cycle.

LOS ANGELES



Los Angeles (Ian Sturton)

GENERAL SPECIFICATIONS

Country: USA

Class: LOS ANGELES

Built: 55
Active: 55
Building: 4

Displacement: See following table

Hull numbers	Surfaced	Submerged
SSN 688-699	6,080 t	6,927 t
SSN 700-714	6,130 t	6,977 t
SSN 716-718	6,165 t	7,012 t
SSN 719-750	6,255 t	7,102 t
SSN 751-770	6,300 t	7,147 t
SNN 771-773	6,330 t	7,177 t

Dimensions
Length: 110.3 m (362 ft)
Beam: 10.1 m (33 ft)
Draught: 9.9 m (32.3 ft)

Speed: 32 kts dived
Diving depth: n/k

Complement: 133 (13 officers)

SUBMARINES

LOS ANGELES (SSN 688)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 8 Jan 1972
Launched 6 Apr 1974
Commissioned 13 Nov 1976

PHILADELPHIA (SSN 690)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 12 Aug 1972
Launched 19 Oct 1974
Commissioned 25 Jun 1977

MEMPHIS (SSN 691)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 23 Jun 1973
Launched 3 Apr 1976
Commissioned 17 Dec 1977

GROTON (SSN 694)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 3 Aug 1973
Launched 9 Oct 1976
Commissioned 8 Jul 1978

BIRMINGHAM (SSN 695)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 26 Apr 1975
Launched 29 Oct 1977
Commissioned 16 Dec 1978

NEW YORK CITY (SSN 696)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 15 Dec 1973
Launched 18 Jun 1977
Commissioned 3 Mar 1979

INDIANAPOLIS (SSN 697)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 19 Oct 1974
Launched 30 Jul 1977
Commissioned 5 Jan 1980

BREMERTON (SSN 698)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 8 May 1976
Launched 22 Jul 1978
Commissioned 14 Mar 1981

JACKSONVILLE (SSN 699)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 21 Feb 1976
Launched 18 Nov 1978
Commissioned 16 May 1981

DALLAS (SSN 700)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 9 Oct 1976
Launched 28 Apr 1979
Commissioned 18 Jul 1981

LA JOLLA (SSN 701)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 16 Oct 1976
Launched 11 Aug 1979
Commissioned 24 Oct 1981

PHOENIX (SSN 702)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 30 Jul 1977
Launched 8 Dec 1979
Commissioned 19 Dec 1981

BOSTON (SSN 703)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 11 Aug 1978
Launched 19 Apr 1980
Commissioned 30 Jan 1982

BALTIMORE (SSN 704)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 21 May 1979
Launched 13 Dec 1980
Commissioned 24 Jul 1982

CITY OF CORPUS CHRISTI (SSN 705)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 4 Sep 1979
Launched 25 Apr 1981
Commissioned 8 Jan 1983

ALBUQUERQUE (SSN 706)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 27 Dec 1979
Launched 13 Mar 1982
Commissioned 21 May 1983

PORTSMOUTH (SSN 707)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 8 May 1980
Launched 18 Sep 1982
Commissioned 1 Oct 1983

MINNEAPOLIS-SAINT PAUL (SSN 708)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 30 Jan 1981
Launched 19 Mar 1983
Commissioned 10 Mar 1984

HYMAN G RICKOVER (SSN 709)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 24 Jul 1981
Launched 27 Aug 1983
Commissioned 21 Jul 1984

AUGUSTA (SSN 710)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 1 Apr 1982
Launched 21 Jan 1984
Commissioned 19 Jan 1985

SAN FRANCISCO (SSN 711)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 26 May 1977
Launched 27 Oct 1979
Commissioned 24 Apr 1981

ATLANTA (SSN 712)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 17 Aug 1978
Launched 16 Aug 1980
Commissioned 6 Mar 1982

HOUSTON (SSN 713)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 29 Jan 1979
Launched 21 Mar 1981
Commissioned 25 Sep 1982

NORFOLK (SSN 714)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 1 Aug 1979
Launched 31 Oct 1981
Commissioned 21 May 1983

BUFFALO (SSN 715)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 25 Jan 1980
Launched 8 May 1982
Commissioned 5 Nov 1983

SALT LAKE CITY (SSN 716)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 26 Aug 1980
Launched 16 Oct 1982
Commissioned 12 May 1984

OLYMPIA (SSN 717)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 31 Mar 1981
Launched 30 Apr 1983
Commissioned 17 Nov 1984

HONOLULU (SSN 718)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 10 Nov 1981
Launched 24 Sep 1983
Commissioned 6 Jul 1985

PROVIDENCE (SSN 719)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 14 Oct 1982
Launched 4 Aug 1984
Commissioned 27 Aug 1985

PITTSBURGH (SSN 720)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 15 Apr 1983
Launched 8 Dec 1984
Commissioned 23 Nov 1985

CHICAGO (SSN 721)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 5 Jan 1983
Launched 13 Oct 1984
Commissioned 27 Sep 1986

KEY WEST (SSN 722)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 6 Jul 1983
Launched 20 Jul 1985
Commissioned 12 Sep 1987

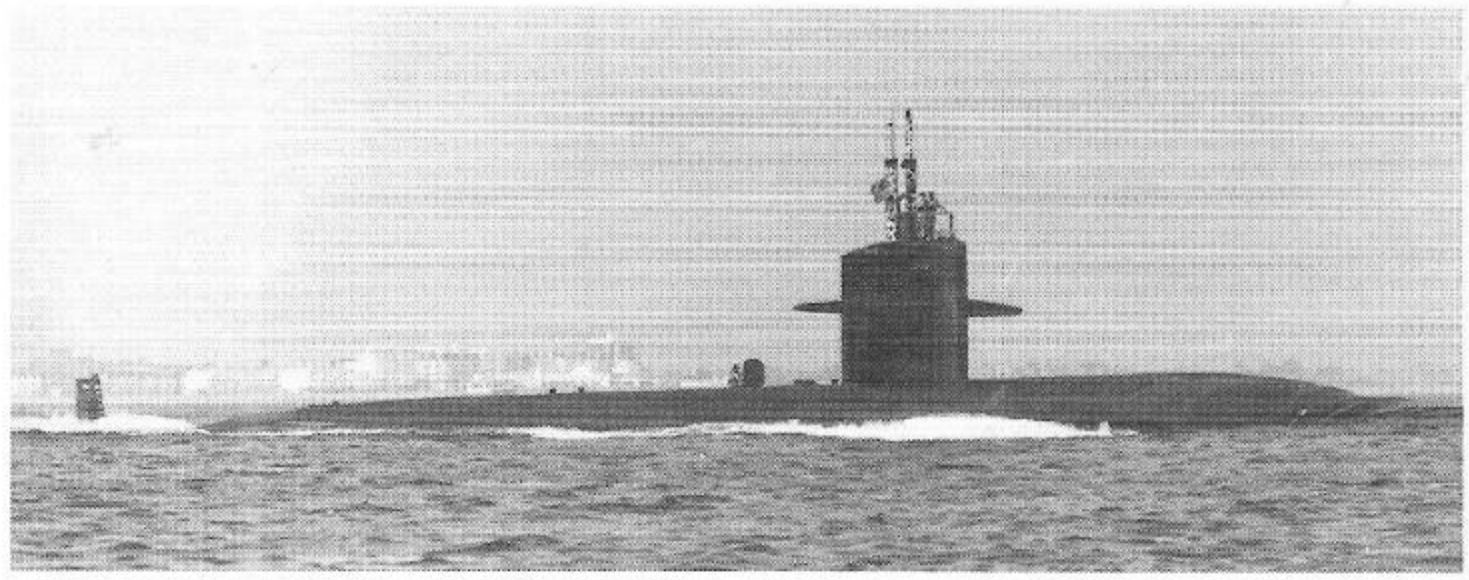
OKLAHOMA CITY (SSN 723)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 4 Jan 1984
Launched 2 Nov 1985
Commissioned 9 Jun 1988

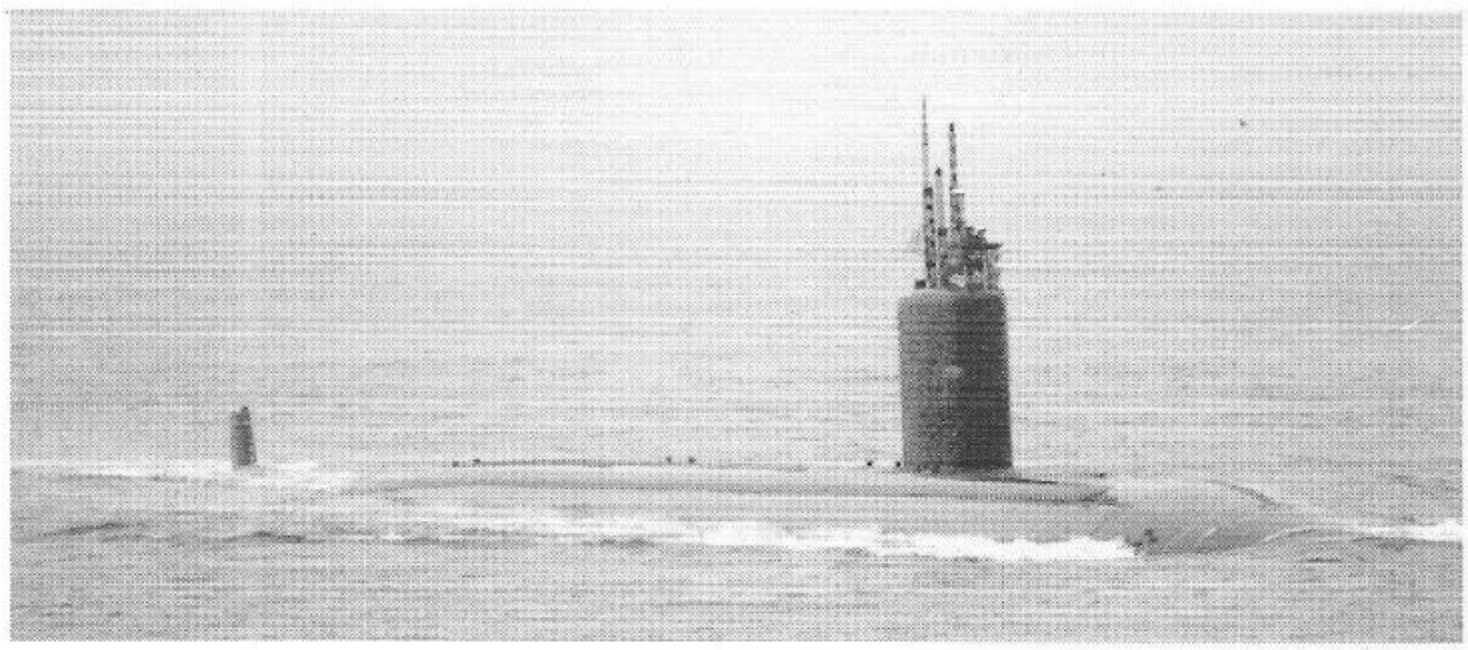
LOUISVILLE (SSN 724)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 16 Sep 1984
Launched 14 Dec 1985
Commissioned 8 Nov 1986

HELENA (SSN 725)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 28 Mar 1985
Launched 28 Jun 1986
Commissioned 11 Jul 1987

NEWPORT NEWS (SSN 750)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 3 Mar 1984
Launched 15 Mar 1986
Commissioned 3 Jun 1989

SAN JUAN (SSN 751)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 16 Aug 1985
Launched 6 Dec 1986
Commissioned 6 Aug 1988





Groton *(SSN 694) (above) showing the forward hydroplanes on the sail, as fitted in SSN 688 to SSN 750, and* San Juan *(SSN 751) (below) the first to have the hydroplanes moved to the bows* (H & L van Ginderen Collection)

SADENA (SSN 752)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 20 Dec 1985
Launched 12 Sep 1987
Commissioned 11 Feb 1989

ALBANY (SSN 753)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 22 Apr 1985
Launched 13 Jun 1987
Commissioned 7 Apr 1990

TOPEKA (SSN 754)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 13 May 1986
Launched 23 Jan 1988
Commissioned 21 Oct 1989

MIAMI (SSN 755)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 24 Oct 1986
Launched 12 Nov 1988
Commissioned 30 Jun 1990

SCRANTON (SSN 756)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 29 Jun 1986
Launched 3 Jul 1989
Commissioned 26 Jan 1991

ALEXANDRIA (SSN 757)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 19 Jun 1987
Launched 23 Jun 1990
Commissioned 29 Jun 1991

ASHEVILLE (SSN 758)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 1 Jan 1987
Launched 28 Oct 1989
Commissioned 28 Sep 1991

JEFFERSON CITY (SSN 759)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 21 Sep 1987
Launched 24 Mar 1990
Commissioned 30 Jan 1992

ANNAPOLIS (SSN 760)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 15 Jun 1988
Launched 18 May 1991
Commissioned 11 Apr 1992

SPRINGFIELD (SSN 761)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 29 Jan 1990
Launched 4 Jan 1992
Commissioned 9 Jan 1993

COLUMBUS (SSN 762)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 7 Jan 1991
Launched 1 Aug 1992
Commissioned 24 Jul 1993

SANTA FE (SSN 763)
Builder General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down 9 Jul 1991
Launched 12 Dec 1992
Commissioned 8 Jan 1994

BOISE (SSN 764)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 25 Aug 1988
Launched 20 Oct 1990
Commissioned 7 Nov 1992

MONTPELIER (SSN 765)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 19 May 1989
Launched 6 Apr 1991
Commissioned 13 Mar 1993

CHARLOTTE (SSN 766)
Builder Newport News Shipbuilding, Newport News, Virginia, USA
Laid down 17 Aug 1990
Launched 3 Oct 1992
Commissioned 10 Oct 1994

HAMPTON (SSN 767)

Builder	Newport News Shipbuilding, Newport News, Virginia, USA
Laid down	2 Mar 1990
Launched	28 Sep 1991
Commissioned	6 Nov 1993

HARTFORD (SSN 768)

Builder	General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down	27 Apr 1992
Launched	4 Dec 1993
Commissioned	10 Dec 1994

TOLEDO (SSN 769)

Builder	Newport News Shipbuilding, Newport News, Virginia, USA
Laid down	6 May 1991
Launched	28 Aug 1993
Commissioned	9 Mar 1995

TUCSON (SSN 770)

Builder	Newport News Shipbuilding, Newport News, Virginia, USA
Laid down	15 Aug 1991
Launched	15 Mar 1994
Commissioned	9 Sep 1995

COLUMBIA (SSN 771)

Builder	General Dynamics (Electric Boat Division), Groton, Connecticut, USA
Laid down	24 Apr 1993
Launched	24 Sep 1994
Commissioned	9 Oct 1995

GREENEVILLE (SSN 772)

Builder	Newport News Shipbuilding, Newport News, Virginia, USA
Laid down	28 Feb 1992
Launched	17 Sep 1994
Commissioned	16 Feb 1996

CHEYENNE (SSN 773)

Builder	Newport News Shipbuilding, Newport News, Virginia, USA
Laid down	6 Jul 1992
Launched	2 Apr 1995
Commissioned	Aug 1996

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

BGM-109 Tomahawk

Submarine-launched Tomahawks are in service in three versions: two land attack versions, one with a conventional HE warhead BGM-109C Tomahawk Land Attack Missile - Conventional (TLAM-C) and another with submunitions BGM-109D Tomahawk Land Attack Missile-D (TLAM-D); and the BGM-109B Tomahawk Anti-Ship Missile (TASM) also with a conventional HE warhead. A fourth version, BGM-109A Tomahawk Land Attack Missile - Nuclear (TLAM-N) has been retired as a result of START I.

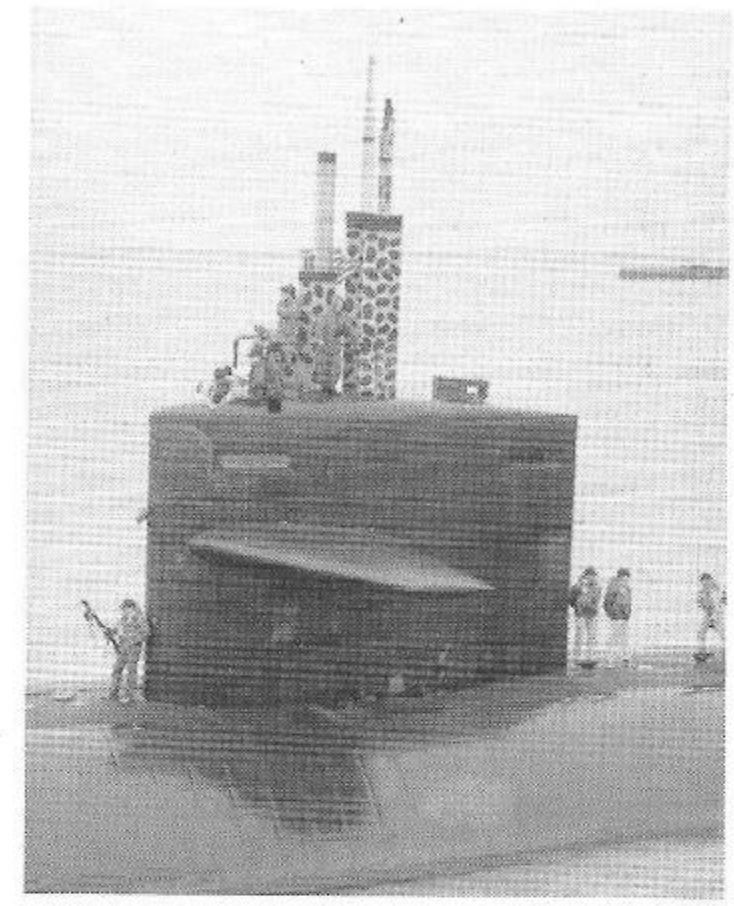
Different airframe production standards are referred to by 'Block' numbers. Thus, the majority now in service is Block II, although the Block III has been in production since 1993 and Block II missiles are progressively being brought up to the new standard.

The missile is launched from either a vertical launch tube or from a conventional 533 mm torpedo tube in a capsule and is then driven up towards the surface where it leaves the capsule just before broaching. The rocket booster drives it up into the atmosphere where the turbojet engine takes over and the booster is jettisoned.

Guidance varies between the versions. BGM-109A uses inertial navigation with terrain contour matching (Tercom), while BGM-109B uses inertial plus active radar terminal guidance, and BGM-109C/D inertial and Tercom mid-course guidance with Digital Scene Matching Area Correlation (DSMAC) for terminal guidance. Tercom stores digital terrain profile map information in the missile before launch, which is compared with radar altimeter measurements of ground elevations below the missile during a set number of sections en route to the target. The Block III upgrade programme will include a Global Positioning System (GPS) receiver to supplement or replace the Tercom system. In the terminal phase, DSMAC compares a stored digital representation of the target area with the scene viewed below the missile by a TV camera. This latter system is claimed to be extremely accurate for attacking land targets, with a circular error probable (cep) of 10 m being reported. Both the BGM-109C and D versions have a programmable terminal dive attack mode option.

The BGM-109A is fitted with a W80 135 kg (297.7 lb) nuclear warhead, the BGM-109B/C with old Bullpup B 454 kg unitary HE warheads, and the BGM-109D with 166 combined effects bomblets BLU-97B each weighing 1.5 kg (3.3 lb) and with shaped charges, fragmentation and incendiary capabilities. These submunitions can be dispensed in groups against up to four separate targets.

Block III missiles have a more powerful turbofan engine, which is also more fuel efficient, which, coupled with increased fuel capacity, results in a range



Cincinnati *(SSN 693) showing details of the sail-mounted sensors and the outlines of the anechoic tiles which cover the hull* (H & L van Ginderen Collection)

Specifications

Designation	BGM-109B (Note 1)	BGM-109C Block II	BGM-109D Block II	Block III
Mission	Tomahawk anti-ship missile (TASM)	Tomahawk land attack missile - conventional (TLAM-C)	Tomahawk land attack missile - D (TLAM-D)	
Airframe standard	Block II	Block II	Block II	Block III
Length	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)
Diameter	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)
Wing span	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)
Launch weight	1,452 kg (3,201 lb)	1,452 kg (3,201 lb)	1,452 kg (3,201 lb)	n/k
Warheads	454 kg HE (1,000 lb)	454 kg HE (1,000 lb)	166 bomblets	320 kg (705 lb)
Range	240 n miles (450 km)	490-700 n miles (900-1,300 km)	490 n miles (900 km)	690-1,000 n miles (1,285-1,857 km)
Accuracy — circular error probable (cep)	n/a	10 m (33 ft)	10 m (33 ft)	10 m (33 ft)
Speed	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)
In-service date	1983	1983	1989	1993
Engine	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR402 turbofan (335 kg thrust)
Number currently on order	593	1,486	1,157	

Notes:
1. BGM-109A is not listed as it has been withdrawn from service.

increase of at least 30 per cent. The BGM-109C Block III missiles have a smaller WDU-36B 320 kg warhead carrying a unitary HE charge with a selectable fuze delay to increase warhead penetration before detonation.

During the 1991 Gulf War two submarines fired 15 of the total of 264 TLAM-C and 27 TLAM-D fired. Reports from the Gulf War, still unconfirmed, suggest that, apart from those with HE warheads, some Tomahawks carried electromagnetic pulse (EMP) generators which were used to disrupt electronic and electrical circuits, while others dispensed lengths of carbon fibre which were used to create short-circuits between overhead electrical power supply cables.

Manufacturers/Contractors

Hughes Missile Systems, Tucson, Arizona, USA (prime).
McDonnell Douglas Missile Systems, St Louis, Missouri (second source).

McDonnell Douglas UGM-84B Sub-Harpoon

All 'Los Angeles' class SSNs carry Sub-Harpoon anti-ship missiles as part of their weapon load, which are either Block 1B or Block 1C versions. Block 1C has a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s.
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

Four amidships-mounted 533 mm (21 in) tubes; air-turbine pump discharge.
Vertical launch tubes (SSN 719 onwards) -12.
Total weapon load, 26 weapons; for example - eight Tomahawk, four Harpoon, 14 torpedoes.

TORPEDOES

Mk 48 Torpedo

The Mk 48 torpedo is an anti-submarine and anti-ship torpedo, capable of operating in wire-guided, active or passive, acoustic and non-acoustic modes. The acoustic modes of operation allow active or passive target detection capabilities. The original Mk 48 torpedo was developed in response to a US Navy operational requirement to meet the growing threat posed by Soviet submarines. The requirement, in November 1960, sought a weapon which, compared with the existing Mk 37, would have 400 per cent more range, 100 per cent more speed, 150 per cent increase in diving depth and be able to acquire targets at 17 per cent greater range. The Gould Mk 48 entered production in the early 1970s and an improved version, Mod 3, began deliveries in 1977 but the appearance in November 1978 of the Soviet 'Alfa' class submarines, capable of 40 knots, led to a re-examination of US Navy torpedo requirements. Urgent tests showed that the Mk 48 was more capable than had been thought and modifications were produced to take advantage of the weapon's full capabilities in a programme known as the Mk 48 Mod 4 Near-Term Update (NTU), with first deliveries in December 1980. The longer-term solution was an ADvanced CAPability (ADCAP) and prototypes first ran in 1982 with the type entering production in 1989 as the Mk 48 ADCAP. In May 1988 Westinghouse won a second source contract.

Externally the Mk 48 is a long slim cylinder with a flat nose and four fin-like wire dispensers faired into the afterbody ahead of the shrouded, axial-flow, pump-jet propulsor. From the Mod 3 onwards, the wire-link is two-way, enabling data from the weapon's homing and guidance system to be relayed to the submarine fire-control system, so that the weapon can be guided more accurately from the submarine.

The Mk 48 ADCAP includes a totally new nose housing the acoustics and beam-forming circuits. There is also a new signal processing system using the latest electronics, incorporating a Litton/Singer inertial measurement unit and computers programmed in CMS-2 software. Warhead sensor electronics have also been improved by Loral. The Hughes command control element has been improved to meet the expanding operating envelope (greater depth, target speed and weapon speed options) and improved surface target capabilities. The fuel tank and afterbody sections, produced by Argo-Tech, have been modified for increased fuel delivery rate and greater capacity for improved speed and endurance.

Specifications

	Mk 48 Mod 4	Mk 48 ADCAP
Length	5.84 m (19.16 ft)	5.84 m (19.16 ft)
Diameter	533 mm (21 in)	533 mm (21 in)
Weight	633 kg (1,396 lb)	1,587 kg (3,500 lb)
Max speed		55 kts
Max range	17.4 n miles (32.2 km)	24.5 n miles (45.75 km)
Max depth	760 m (2,490 ft)	900 m (2,950 ft)
Warhead	n/k	267 kg (589 lb)

Manufacturers/Contractors

Hughes Aircraft Company, Ground Systems Group (prime).
Westinghouse Electric Corporation (second source).

MINES

Mk 67 Mobile and Mk 60 CAPTOR mines can be laid and are carried in place of an equivalent number of torpedoes or missiles.

Mk 60 CAPTOR Mine

CAPTOR (a contraction of 'encapsulated torpedo') is an anti-submarine mine, which can be laid by aircraft, surface ships or any submarine equipped with standard 533 mm (21 in) torpedo tubes. It consists of a Mk 46 Mod 4 torpedo inserted into a mine casing and is intended to be deployed in deep water, on or near strategic routes travelled by enemy submarines. The detection and control unit (DCU) is gated to ignore surface traffic, but has no IFF capability, which means that friendly units must be warned of CAPTOR minelaying and positions of deployed mines.

Specifications

Length: 3.7 m (overall)
Diameter: 533 mm (21 in)
Weight: 908 kg (2,000 lb) (incl torpedo and mooring)
Laying depth: Down to approx 300 m (1,000 ft)
Warhead: 43.5 kg (96 lb) PBX-N-103 HE
Range: 1,000 m (1,100 yd)

Manufacturer/Contractor

Loral Systems Group, Akron, Ohio, USA.

Mk 67 SLMM (Submarine-Launched Mobile Mine)

The Mk 67 SLMM is intended to enable US submarines to lay a shallow-water (to approximately 100 m) minefield. The basic element is a converted Mk 37 Mod 2 torpedo, which is launched from a conventional 533 mm (21 in) torpedo tube and then propels itself to the target area, where the engine is switched off and the device sinks to the bottom. This technique enables the submarine to lay a minefield in an area which is navigationally inaccessible or where covert mining is required for tactical (or even political) reasons.

Specifications

Length: 4.09 m
Diameter: 485 mm
Weight: 754 kg
Warhead: 234 kg (516 lb) PBX-N-103 HE
Max depth: 100 m (328 ft)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

BRD-7

BRD-7 is a radio direction-finder with its own mast.

Manufacturer/Contractor

Lockheed Sanders, Nashua, New Hampshire, USA.

WLR-1H

Fitted in SSN 771, 772 and 773 only, WLR-1H is a passive radar-warning system covering frequencies between 0.55 and 20 GHz, using automatic scanning.

Manufacturer/Contractor

ST Research, USA.

WLR-8(V)2

WLR-8(V)2 is a fully digital, solid-state, tactical electronic warfare and surveillance receiver designed specifically for 'Los Angeles' class SSNs. Covering frequencies from 50 MHz to 18 GHz, it provides comprehensive ESM (Electronic Support Measures) facilities and is compatible with NTDS (Navy Tactical Data System). There are two computers: GTE PSP-300 for system control, automatic signal acquisition and analysis, and file processing; and a GTE PSP-200 microcomputer for hardware level control functions. Operational facilities include: automatic measurement of signal direction-of-arrival; signal classification and recognition; sequential or simultaneous scanning over a wide frequency range; signal activity detection for threat warning; and the analysis of signal parameters (for example, frequency, PRF, modulation, pulsewidth, amplitude and scan rate). WLR-8(V)2 reports direct to onboard computers, such as NTDS, thus giving response times in the millisecond range with minimal operator involvement.

Manufacturer/Contractor
GTE Electronic Defense Systems Sector, Mountain View, California, USA.

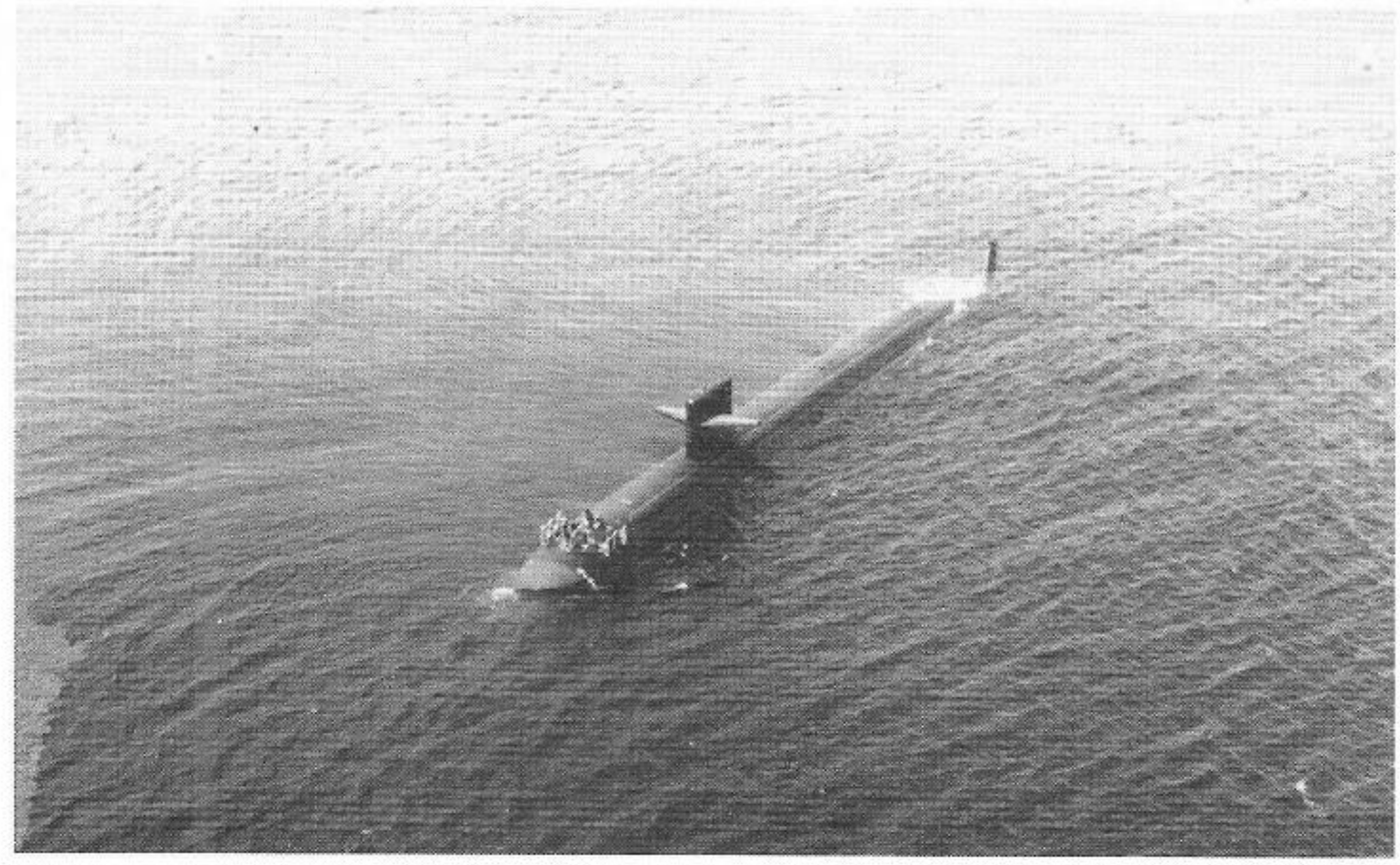
WLR-9
The WLR-9 acoustic intercept receiver is part of the BQQ-5 sonar suite and provides information on active sonars as well as detecting incoming homing torpedoes using active seekers. The hydrophone is normally mounted in a separate fairing on the sail topside and forward on the hull.

Manufacturer/Contractor
Norden Systems, Melville, New York, USA.

WLR-10
The WLR-10 radar warning system shares an antenna with WLR-8.

DECOYS

There are two types of anti-torpedo decoys. ADCs (Acoustic Devices, Countermeasure), of which some ten versions are believed to exist, are small, launched from special tubes, and take up a static position at some distance from the submarine, where they emit signals to decoy incoming torpedoes. Other devices, known as MOSS (Mobile Submarine Simulators), are launched from 533 mm (21 in) torpedo tubes and are fitted with noise-makers to divert the attention of sensors aboard hostile submarines; they are only deployed in SSBNs. Details of both ADCs and MOSS are, not surprisingly, classified.



Los Angeles *(SSN-688) with the hatches for the twelve-tube Tomahawk vertical launch system open* (US Navy)

ADC Mk 2 Mod 1
The ADC (Acoustic Device, Countermeasure) Mk 2 Mod 1 is a submarine-launched decoy designed to counter acoustic torpedoes. Launched from an 80 mm (3.1 in) diameter tube, the device, which looks like a small torpedo, moves to a preselected depth, where it uses its nose-mounted propeller to hover vertically, emitting an acoustic signal.

Manufacturers/Contractors
ESCO Electronics (formerly Emerson Electric Co) (prime).
Hazeltine Corp (an ESCO subsidiary) Greenlawn, New York, USA (current production).

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

CCS Mk 2
CCS Mk 2 (Command and Control System Mk 2) is fitted in SSNs 688-750 to provide command and control, weapons control, TMA (target motion analysis) and OTH (over-the-horizon) targeting capabilities. It makes extensive use of government off-the-shelf (GOTS) hardware and software products and limited use of commercial off-the-shelf (COTS) items. The primary computer is the Paramax AN/UYK-43, while a UYK-44 processes over-the-horizon targeting software, supplemented by a CP-2037/UYK parallel processor to speed up target track correlation. The modular software packages are written in both CMS-2 and Ada. There are four Mk 130 Common Display Systems (CDS) which improve operator interaction with the system while two can be used for over-the-horizon targeting. The Mk 130 is based upon Silicon Graphics technology, and is capable of an operating speed of 8 Mips.

Manufacturer/Contractor
Raytheon Submarine Signal Division, Portsmouth, Rhode Island, USA.

BSY-1(V)
BSY-1(V) is a fully integrated combat system, currently installed in SSN 751 to SSN 773, both inclusive. The system was developed to equip the 'Los Angeles' class attack submarines and is the US Navy's first submarine combat system to integrate navigation, sonar and weapons system data in order to improve the target detection, classification, localisation, combat control and weapons launch functions. Included in this integration process are the Submarine Active Detection System (SADS) (see next page), the Mine and Ice Detection Avoidance System (MIDAS) and the TB-16 and TB-23 towed passive arrays.

The integrated combat system carries out target motion analysis (TMA) and calculates fire-control solutions for Mk 48 ADCAP torpedoes, Harpoon and Tomahawk cruise missiles, one of its main aims being to reduce the response time between initial detection and weapon launch found in earlier systems. The system utilises the latest computers, data displays and has the software and automation necessary to enable operators to perform multiple tasks and handle multiple targets simultaneously. The system uses some 3.6 million lines of tactical software code.

The first boat to receive the system was SSN 751 in mid-1987, since when a further 18 have received the system; all 19 have also received the Navy's new standard AN/UYK-43 computer, which replaces the AN/UYK-7. The latest version of the system, which incorporates the latest version of the Tomahawk fire control and acoustic improvements, is designated 'ECI-010 Level,' and as of September 1994, 10 submarines had been upgraded to this standard. 25 AN/BSY-1 systems have been ordered, of which 23 are for submarines and two for shore-side training.

Manufacturers/Contractors
Loral Federal Systems, Manassas, Virginia, USA (production).
Lockheed Martin, Syracuse, New York, USA (towed array).
Raytheon Company, Submarine Signal Division, Portsmouth, Rhode Island, USA (hull array).
General Electric, Moorestown, New Jersey, USA (production).
EG&G, Rockville, Maryland, USA (systems engineering).

COMMUNICATIONS AND DATALINKS

TADIX-A
The Tactical Digital Information Exchange (TADIX) system receives one-way transmissions of ocean-surveillance data via satellite.

BGIXS
Battle Group Information Exchange System.

JOTS
Joint Operational Tactical System.

WEAPONS CONTROL

Mk 117 Mod 0 FCS
The Mk 117 Mod 0 fire-control system is fitted in SSN 700 onwards during build and is being retrofitted to earlier boats. Mk 117 FCS is a mainframe architecture system based upon a two-bay UYK-7 computer using software written in C and CMS-2 languages. There are three Mk 81 Mod 1/2 Weapon Control Consoles (WCC) and one Mk 92 Mod 0/2 multipurpose console to which is added a Mk 82 weapon data converter to act as an Attack Control Console (ACC). The WCCs are used for target tracking, TMA, attack evaluation, calculating ballistic solutions and calculating presetting instructions for the weapons. The ACC includes the firing panel and monitors the weapons status and presets the weapons. The Mk 117 is usually associated with the IBM AN/BQQ-5 digital multibeam system which uses hull-mounted and towed array sonars with data processed by a dedicated UYK-7 which then communicates this data to the UYK-7 associated with the fire-control system. The hull-mounted elements consist of bow-mounted active/passive spherical array subsystem based upon the BQS-13 DNA (Digital multibeam Narrowband accelerated Active search) sonar set and a bow-mounted passive conformal low-frequency array, which is reported to have nothing like the aperture of the earlier BQR-7 sonar. The BQQ-5 features include DIMUS (Digital Multibeam Steering), passive classification, online performance monitoring and improved displays. Ice and mine detection is provided through the Hazeltine AN/BQS-14 or BQS-15 sonars, although they are not integrated into the BQQ-5.

RADAR

BPS-15A/-16
BPS-15A and its successor BPS-16 are surface search and navigational radars, with a horn antenna mounted well forward on the sail.

Specifications
Band: I/J
Beam: 3 × 13°
Peak power: 35 kW
Gain: 29 dB
Pulsewidth: 0.1/0.5 µs
Pulse repetition frequency: 1,500/750 pps
Scan rate: Max 9.5 rpm

Manufacturer/Contractor
Sperry Marine, Charlottesville, Virginia, USA.

SONARS

BQQ-5D/E

BQQ-5 is the sonar suite developed specifically for the 'Los Angeles' class. In essence, BQS-6 was updated to solid-state electronics to become the BQS-13, which, with the addition of DIMUS then became BQQ-5, while other elements of the suite include the BQS-14 ice-avoidance sonar and the WLR-9 acoustic intercept receiver. The system can be used to attack a large number of targets simultaneously. Current versions are BQQ-5D, which is matched to BSY-1 and BQQ-5E and incorporates the TB-12 thin line, towed array.

Manufacturer/Contractor

IBM, Federal Systems Division, USA.

BQG-5D

BQG-5D (also known as the Wide Aperture Array (WAA)) is installed in SSN 710 and SSN 751 onwards. There are six large, flat arrays, three on each side of the hull.

Manufacturer/Contractor

Lockheed Martin. Ocean Radar and Systems Division, Glen Burnie, Maryland, USA.

BQR-23/BQR-25

The Submarine Towed Array Sonar System (STASS) consists of two elements: the BQR-15 'wet end' and the BQR-23 signal processor or 'dry end.' BQR-25 consists of a cable some 300 m (1,000 ft) long and 2.5 cm (1 in) in diameter, with the sonar array itself being 90 m (298 ft) long and 5 cm (2 in) in diameter. The cable is clipped on leaving the channel entrance, a notoriously difficult procedure. BQR-15 is being replaced by TB-23/29 thin line array during refits.

BQS-15

BQS-15 is the primary sonar used for under-ice navigation and detection installed in the earlier boats which do not have MIDAS (see below) and was designed specifically for the needs of the 'Los Angeles' class. It is integrated as part of the SADS-TG system. An active system, it is mounted high on the forward edge of the sail and operates in the sonar high-frequency band. BQS-15 operates in an entirely different way from BQS-14, with a mechanically steered planar array

Manufacturer/Contractor

Ametek Inc, Paoli, Pennsylvania, USA.

MIDAS

MIDAS (Mine Detection and Avoidance System) is fitted in SSN 751 onwards. This is a follow-on to the BQS-8, -10, -14, and -15 series of under-ice sonars and the AN/BSY-1 fire-control system. MIDAS has a high-frequency small object locating and tracking capability built into the bow-mounted, spherical array which is an important advance, since the older, sail-mounted, active, under-ice sonars could only look directly ahead and a large area was blocked by the ship's bow. As a result, the submarine had to follow a sinusoidal course and to be trimmed down by the bow as much as possible (up to about 3.5°) to give adequate depth coverage.

SADS-TG

The Submarine Active Detection System-Transmit Group (SADS-TG) is a bow-mounted, medium- to low-frequency sonar used for the detection and fire-control solutions on subsurface-to-surface targets. It has 360° coverage and is being retrofitted.

Manufacturer/Contractor

Raytheon Company, Submarine Signal Division, Portsmouth, Rhode Island, USA.

TB-16

Later versions have the Lockheed Martin TB-16 towed array which is 800 m (2,625 ft) long, 8.25 mm (0.32 in) in diameter with an acoustic module about 75 m (250 ft) long. The TB-16 is normally stowed in a tube running outside the pressure hull with the winch cable and reel in the forward main ballast tank. It will be replaced by the lightweight Lockheed Martin TB-23 which will be housed on a reel in the main ballast tank.

Manufacturer/Contractor

Lockheed Martin, Ocean Radar and Systems Division, Glen Burnie, Maryland, USA.

PROPULSION

Specifications

System: Nuclear
Reactor: 1 General Electric S6G pressurised water reactor
Turbines: 2
Power output: 26 MW (35,000 hp)
Shaft: 1
Propeller: 1—7-blade propeller
Auxiliary propulsion: 1 Fairbanks-Morse 38DQ diesel generator and batteries; 1 Magnetek electric motor; 242 kW (325 hp)

FURTHER INFORMATION

PROGRAMME

This is one of the greatest defence programmes ever undertaken. When the building programme ends 62 'Los Angeles' class SSNs will have been built over a period of 20 years; indeed, three have already been stricken, at the end of very active and useful lives, before the last entered service. Further, throughout the long life of the programme the 'Los Angeles' class has provided the yardstick against which all other submarines have been measured.

The cost of such a long drawn-out programme is difficult to assess, but sample costs per boat (in 'then year' dollars) were: 1976—$225 million; 1979—$326 million; 1981—$325.6 million, and 1983—$844 million. This suggests that, in very round terms, the total programme cost may have been of the order of $55,000,000,000. Against this, these boats have been regularly improved and have been constantly in service in every ocean in the world. Further, they took the Cold War to the gates of the Soviet SSBN bastions and in the Gulf War launched 15 of the Tomahawks which attacked Baghdad.

The first of class was laid down in 1972 and commissioned in 1976 and at least one and frequently more, have joined the fleet in every year from then until 1995.

Various major improvement programmes and updating design changes caused programme delays in the late 1980s, not helped by a long strike at the Electric Boat Division. From (SSN 751 onwards the class is prefixed by an 'I' for 'improved'). The programme has ended with the 62nd hull, and the earliest boats are now being paid off as they come up for refuelling, three having already done so.

DESIGN

The Los Angeles hull is considerably larger than that of its predecessor, the 'Sturgeon' class. The Los Angeles are longer (109.8 m versus 89.1 m) and the hull has a greater diameter (10.1 m versus 9.7 m) which increases submerged displacement from 4,777 t to 6,900 t. This greater internal volume enabled a much more powerful nuclear plant to be installed, the Los Angeles S6G having a power output of 26 MW compared to the Sturgeons' S5W plant with 11.2 MW. The additional internal volume also gave the crew excellent access to all engineering equipment enabling preventive and corrective maintenance to be carried out.

The S6G reactor is a modified version of the D2G type fitted in the cruisers *Bainbridge* and *Truxtun*. Reactor core life between refuellings is estimated at 10 years.

The table showing the steady increase in displacement at the start of the entry illustrates how the 'reserve space and weight' which is built into each new design is rapidly consumed by each successive 'flight' as improvements are incorporated into the design.

The hulls are constructed of HY80 steel, except for SSN-753 and -754, which incorporate several sections of HY100 steel to test its suitability for use in the 'Seawolf' class.

The sensor fit is comprehensive and includes the bow-mounted BQQ-5 sonar, which is covered by a huge, single-piece fibreglass dome, and the passive BQR-15 tactical towed array, whose cable and winch are mounted in the ballast tanks, while the array is housed in the prominent fairing running along the starboard topside of the hull.

MODERNISATION

In such a long-running programme it is inevitable that there have been constant improvements, most of which have been installed in new-build boats and retrofitted to the older boats. Constant efforts have been made to improve sound quieting and from SSN 751 onwards the class has acoustic tile cladding.

Early boats were modified internally to enable them to launch Tomahawk missiles from their torpedo tubes, but when it was realised that this reduced the number of torpedoes that could be carried, 12 vertical launch tubes were fitted in SSN-719 and all subsequent boats, immediately abaft the BQQ-5 sonar dome. The nuclear version of Tomahawk (TLAM-N) is no longer embarked but remains available ashore, while SUBROC ASW missiles were phased-out in 1990, principally because they contained analogue systems which were totally incompatible with the digital fire-control systems then being installed.

SSN-756 and later boats are capable of carrying and launching mines, but only at the expense of some of the torpedo load. In addition, SSN-768 onwards have two additional stern fins (as proposed for the 'Seawolf' class), improved sound quieting and upgraded propulsion systems. One of the major shortcomings of the original SSN-688 design was that the forward hydroplanes were positioned on the sail where they interfered with the boats' ability to surface through ice, and from SSN-751 onwards these have been deleted and replaced by retractable planes in the bows.

Memphis (SSN 691) was withdrawn from active service in late 1989 to become an interim research platform for advanced submarine technology and the early trials did not require major changes to the submarine. The boat is, however, undergoing a major overhaul lasting from January 1994 to mid-1997 which includes the installation of a large diameter tube for testing the new, large torpedoes and unmanned underwater vehicles (UUVs). A large hangar is being fitted on the after deck to house larger UUVs and towed arrays. One of the main aims is to allow contractors easy access for trials at sea of new equipment.

Augusta (SSN 710) was the trials platform for the BQG-5D wide aperture array (WAA) passive sonar system, which is being installed in the SSN 21 class and may also be retrofitted in at least some of the 'Los Angeles' class. One of the prime advantages claimed for wide-angle arrays is that they provide a near instantaneous range to the target, using a combination of triangulation and wave-front curvature measurement of the target's radiated noise.

The WLY-1 acoustic intercept and countermeasures system, which was fitted in *Albuquerque* (SSN 706) for testing, will replace WLR 9A/12 acoustic intercept in the late 1990s. EHF communications are also being fitted.

OPERATIONAL

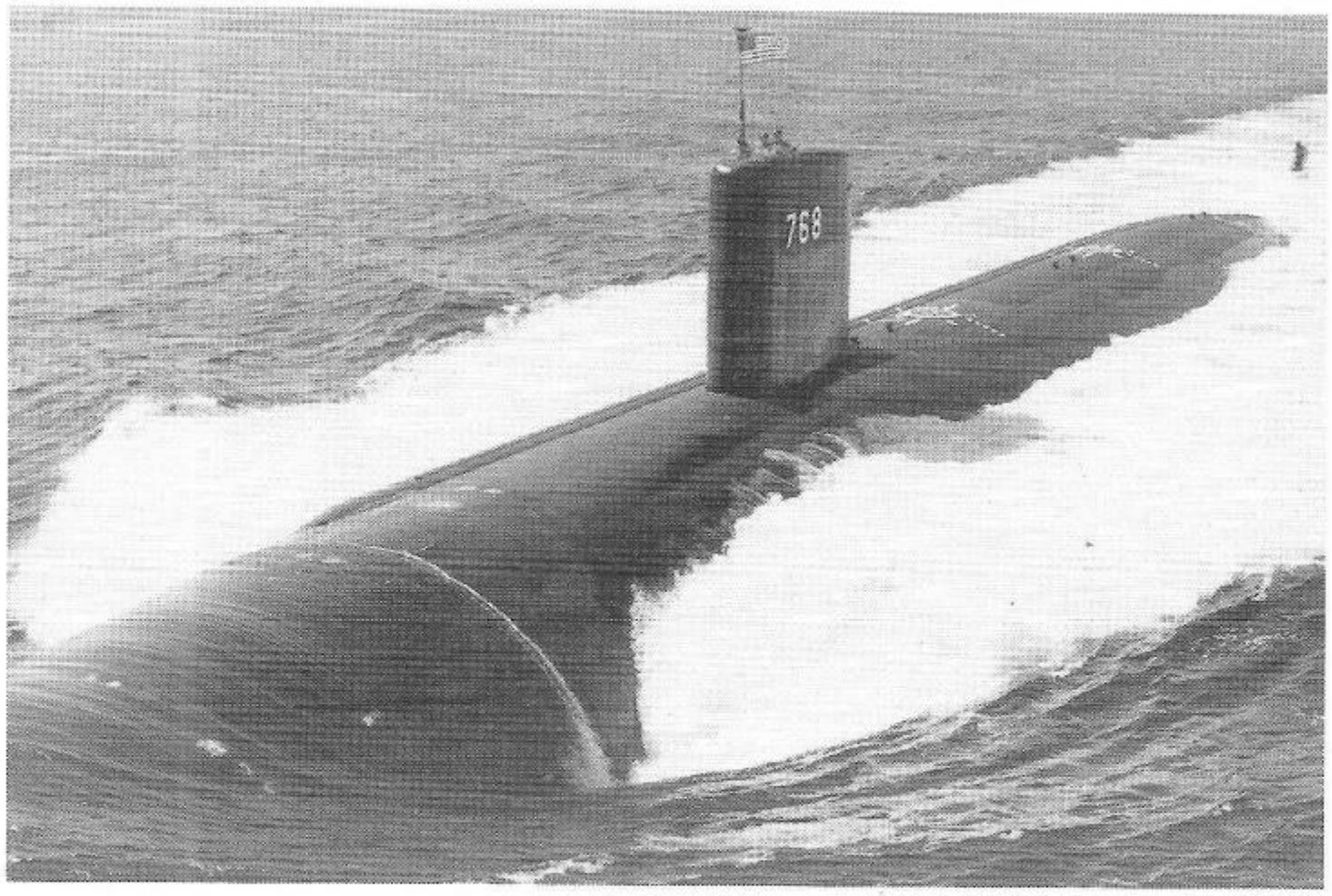
These SSNs were designed during the Cold War, primarily to carry the submarine war to the Soviet 'SSBN bastions' and to take out hostile SSBNs before they could launch their missiles against the USA. The ability of Soviet SSBNs to shelter under the Arctic ice led to a corresponding requirement for US SSNs to operate in the same environment, which resulted in improvements in ice detection sensors, navigation and communications equipment, as well as strengthening the sail and placing the sailplanes forward in later units of the class.

Norfolk fired the first ADCAP torpedo on 23 Jul 1988 and sank the destroyer *Jonas K Ingram*.

Normally eight Tomahawk missiles are carried internally (in addition to the external tubes in SSN 719 onwards) but this load can be increased depending on the mission. Nine of the class took part in the Gulf War against Iraq in 1991, two of which fired Tomahawk missiles, one from the eastern Mediterranean and the other from the Red Sea.

Replacement

There have been repeated criticisms of the costs of the Los Angeles programme and many efforts to produce a cheaper replacement. These projects always sought to obtain as much as possible of the Los Angeles' capabilities and performance at a much reduced price, and always came to naught. One of a number of such attempts was the late 1970s Fleet Attack Submarine (FA-SSN) which would have displaced some 5,000 t and been powered by an S5W reactor, and was estimated to cost only 75 percent of that of a 'Los Angeles' class boat. The first six were actually put into the FY83-85 building programmes, but were eventually cancelled in favour of more 'Los Angeles' class.



Hartford *(SSN 786)* (General Dynamics)

SSN-689 had a minor collision with a Russian Navy 'Sierra' class SSN on 2 November 1992 and was subsequently designated for scrapping. It is also probable that the first 30 units (SSN-688 to SSN-718, both inclusive) will be laid up for disposal rather than have their reactor cores replaced, and *Omaha* (SSN 692) and *Cincinatti* (SSN 693) were, in fact, stricken in FY95.

Concern about retaining nuclear submarine construction expertise in the new strategic environment has led to several proposals to continue production, one such being to construct nine more 'Los Angeles' class at a rate of one per year, as the first nine are stricken, until the New Attack Submarine is ordered, probably in FY98. Meanwhile, the 'Los Angeles' class will continue in service for many years, with regular updates; for example, earlier boats of the class are currently being retrofitted with the Mk 117 Tactical Fire Control System (TFCS).

SEAWOLF

GENERAL SPECIFICATIONS

Country: USA

Class: Seawolf (SSN)

Active: 0
Building: 2
Proposed: 1

Displacement:
surfaced: 7,460 t
submerged: 9,137 t

Dimensions
Length: 107.6 m (352 ft)
Beam: 12.9 m (42.3 ft)
Draught: 10.9 m (35.8 ft)

Speed, submerged: 35 kts
Diving depth: 610 m (2,000 ft) approx

Complement: 133 (12 officers)

SUBMARINES

SEAWOLF (SSN 21)
Builder General Dynamics (Electric Boat Division)
Ordered 9 Jan 1989
Start date 25 Oct 1989
Launched Jul 1995
Commissioned May 1996

CONNECTICUT (SSN 22)
Builder General Dynamics (Electric Boat Division)
Ordered 3 May 1991
Start date 14 Sep 1992
Launched Mar 1997
Commissioned Aug 1998

WEAPONS SYSTEMS

TUBES

Eight 660 mm (26 in) tubes. These are of an entirely new design with an external measurement of 762 mm (30 in), using liners to accommodate 533 mm (21 in) calibre missiles and torpedoes. They also use a new ejection system, which is claimed to be the quietest in service.
Total weapon load, approximately 50 weapons, a mix of Tomahawk (maximum 45), Sub-Harpoon and Mk 48 ADCAP torpedoes.

SURFACE-TO-SURFACE MISSILES (SSM)

BGM-109 Tomahawk

The SSN 21 class SSNs carry a maximum of 45 Tomahawk missiles, of which there are three models, all with conventional (that is, non-nuclear) warheads, currently in service: two land attack versions (BGM-109C Tomahawk Land Attack Missile - Conventional (TLAM-C); and BGM-109D Tomahawk Land Attack Missile-D (TLAM-D)); and BGM-109B Tomahawk Anti-Ship Missile (TASM). A fourth version, BGM-109A Tomahawk Land Attack Missile - Nuclear (TLAM-N) is no longer taken to sea as a result of START I, but all systems remain installed and personnel are trained in their use. It can be expected that SSN 21 class SSNs will only carry the latest Block III missiles.

The missile is launched from a torpedo tube in a capsule and is then driven up towards the surface where it sheds the capsule just before broaching and the rocket booster takes it up into the atmosphere, until the turbojet engine takes over.

Guidance varies between the versions: BGM-109B uses inertial plus active radar terminal guidance, and BGM-109C/D inertial and Tercom mid-course guidance with Digital Scene Matching Area Correlation (DSMAC) for terminal guidance. The Block III upgrade programme has added a Global Positioning System (GPS) receiver to supplement or replace the Tercom system. In the terminal phase, DSMAC compares a stored digital representation of the target area with the scene viewed below the missile by a TV camera. This latter system is claimed to be extremely accurate for attacking land targets, with a circular error probable (cep) of 10 m (32.8 ft) being reported. Both the BGM-109C and D versions have a programmable terminal dive attack mode option.

Block III missiles have a more powerful turbofan engine, which is also more fuel efficient, and this, coupled with increased fuel capacity, results in a range increase of at least 30 per cent. The BGM-109C Block III missiles have a smaller WDU-36B 320 kg warhead carrying a unitary HE charge with a selectable fuze delay to increase warhead penetration before detonation. Unconfirmed reports suggest that, apart from those with HE warheads, some Tomahawks carry electromagnetic pulse (EMP) generators to disrupt electronic and electrical circuits, while others can dispense lengths of carbon fibre to short-circuit overhead electrical power supply cables.

Specifications

Block III
Length: 6.25 m (20.50 ft)
Diameter: 0.52 m (1.71 ft)
Wing span: 2.65 m (8.70 ft)
Launch weight: n/k
Warhead: 320 kg (705 lb)
Range: 690-1,000 n miles (1,285-1,857 km)
Accuracy — circular error probable (cep): 10 m (33 ft)
Speed: Mach 0.7 (550 mph)
In-service date: 1993
Engine: Williams International F107-WR402 turbofan (335 kg thrust)

Manufacturers/Contractors

Hughes Missile Systems, Tucson, Arizona, USA (prime)
McDonnell Douglas Missile Systems, St Louis, Missouri (second source).

McDonnell Douglas UGM-84B Sub-Harpoon

Sub-Harpoon anti-ship missiles will be part of the weapon load, of which the current versions are either Block 1B or Block 1C. Block 1C has a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 kg)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime amd missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TORPEDOES

Mk 48 ADCAP

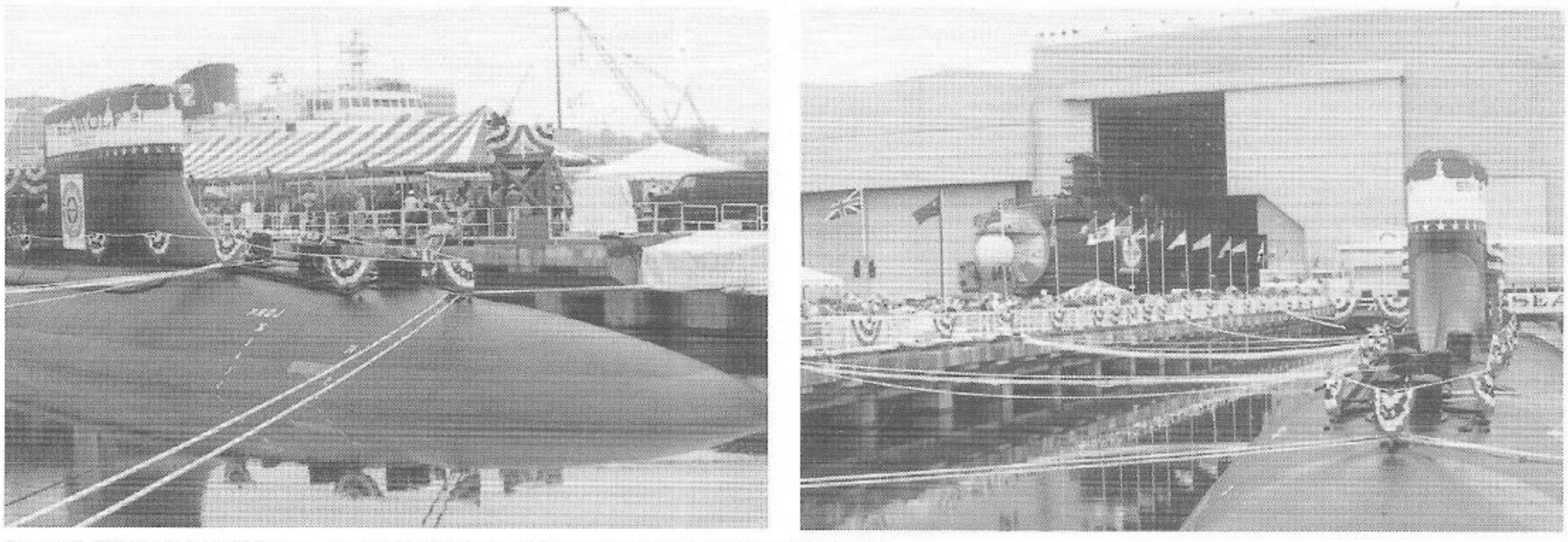
The first torpedo planned for deployment in the SSN 21 class is the Mk 48 ADCAP, which will be able to swim-out of the 660 mm (26 in) tubes, thus making a very quiet, if not silent, exit. ADCAP represents a considerable advance on the Mk 48, including a totally new nose housing the acoustics and beam-forming circuits, new signal processing incorporating a Litton/Singer inertial measurement unit, and computers programmed in CMS-2. Warhead sensor electronics have also been improved by Loral. The Hughes command and control element has been improved to meet the expanding operating envelope (greater depth, target speed and weapon speed options) and to give better capabilities against surface targets. The fuel tank and afterbody sections, produced by Argo-Tech, have been modified to give increased fuel delivery rate and greater capacity, resulting in improved speed and endurance.

Specifications

Length: 5.84 m (19.16 ft)
Diameter: 533 mm (21 in)
Weight: 1,587 kg (3,500 lb)
Max speed: 55 kts
Max range: 24.5 n miles (45.75 km)
Max depth: 900 m (2,950 ft)
Warhead: 267 kg (589 lb)

Manufacturers/Contractors

Hughes Aircraft Company, Ground Systems Group (prime).
Westinghouse Electric Corporation (second source).



Seawolf *(SSN 21) launching ceremony on 24 June 1995* (H & L van Ginderen Collection)

MINES

SSN 21 can carry up to 100 mines in lieu of other weapons.

Mk 60 CAPTOR Mine

CAPTOR (a contraction of 'en*cap*sulated *tor*pedo') is an anti-submarine mine, which can be laid by aircraft, surface ships or any submarine equipped with standard 533 mm (21 in) torpedo tubes. It consists of a Mk 46 Mod 4 torpedo inserted into a mine casing and is intended to be deployed in deep water, on or near strategic routes travelled by enemy submarines. The detection and control unit (DCU) is gated to ignore surface traffic, but has no IFF capability, which means that friendly units must be warned of CAPTOR minelaying and positions of deployed mines.

Specifications
Length: 3.7 m (overall)
Diameter: 533 mm
Weight: 908 kg (2,000 lb) (incl torpedo and mooring)
Laying depth: Down to approximately 300 m (1,000 ft)
Warhead: 43.5 kg (96 lb) PBX-N-103 HE
Range: 1,000 m (1,100 yd)

Manufacturer/Contractor
Loral Systems Group, Akron, Ohio, USA.

Mk 67 SLMM (Submarine-Launched Mobile Mine)

The Mk 67 SLMM is intended to enable US submarines to lay a shallow-water (to approximately 100 m) minefield. The basic element is a converted Mk 37 Mod 2 torpedo, which is launched from a conventional 533 mm (21 in) torpedo tube and then propels itself to the target area, where the engine is switched off and the device sinks to the bottom. This technique enables the submarine to lay a minefield in an area which is inaccessible to the submarine or where covert mining is required for tactical (or even political) reasons.

Specifications
Length: 4.09 m (13.4 ft)
Diameter: 485 mm
Weight: 754 kg (1,662 lb)
Warhead: 234 kg (516 lb) PBX-N-103 HE
Max depth: 100 m (328 ft)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

AN/WLQ-4(V)1

AN/WLQ-4 was developed for 'Sturgeon' class SSNs, but in November 1987, GTE received a $10 million contract to repackage it for the SSN 21 class submarines. This was followed by a $39 million production contract and the first AN/WLQ-4(V)1 systems have been delivered.

AN/WLQ-4(V)1 performs SIGINT missions and is an automated, modular signal collection system which identifies the nature and sources of unknown radar emitters and communications signals. It incorporates a network of mini-computers and microprocessors, and data from these computers are correlated with information received from satellite sensors. The system is part of Sea Nymph, a highly classified US Navy NAVELEX programme. Key features of AN/WLQ-4 system include: automatic search, acquisition and signal processing; automatic logging and reporting; and semi-automatic correlation of real-time measured data with inputs from external systems. The system uses 400,000 lines of AN/UYK-44 source code and 50,000 lines of executable code in 40 microprocessors.

Manufacturer/Contractor
GTE Electronic Defense Systems Sector, Mountain View, California.

ELECTRONIC COUNTERMEASURES (ECM)

SSN 21 will carry the current range of torpedo decoys (for example, MOSS) and the AN/WLY-21 system in due course.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

AN/BSY-2

AN/BSY-2 is a distributed architecture system using Ada software and incorporates CCS Mk 2. It uses more than 1,000 microprocessors including 300 32-bit Motorola 68030s, these processors being used for basic processing, input/output control, cabinet control and signal processing. Computer disk storage is 4.7 Gbytes and Random Access Memory (RAM) is 1.8 Gbytes. The newly developed software includes more than 2 million Source Lines of Code (SLOC) and the total software size exceeds 3 million SLOC. The hardware is linked by a Flexnet local area network capable of 50 Mbit/s.

The acoustic element is the AN/BQG-5 Passive Sonar receiving set (which will also be retrofitted into some of the 'Los Angeles' class) the basis of which is the Lockheed Martin Wide Aperture Array (WAA), a hull-mounted sonar using three widely separated arrays on each side of the hull to improve detection. BQG-5 also uses TB-16D and TB-29 towed array sonars. The new sonar provides longer detection ranges, rapid localisation of targets without the submarine having to manoeuvre, multiple target tracking with greater accuracy and the virtual elimination of flow noise striping.

Manufacturer/Contractor
GE Submarine Combat Systems, Fairfield, Connecticut, USA (prime contractor).

RADAR

BPS-16

BPS-16 is a surface search and navigational radar, with a horn antenna mounted well forward on the sail.

Specifications
Band: I/J
Beam: 3 × 13°
Peak power: 35 kW
Gain: 29 dB
Pulsewidth: 0.1/0.5 µs
Pulse repetition frequency: 1,500/750 pps
Scan rate: Max 9.5 rpm

Manufacturer/Contractor
Sperry Marine, Charlottesville, Virginia, USA.

SONAR

BQG-5 suite

BQG-5 (Wide Aperture Array (WAA)) is a hull-mounted sonar, using three widely separated, rectangular arrays (which show up prominently in most photographs of SSN 21 so far released) to improve detection. It also employs the TB-16D towed array for surveillance and the TB-29 tactical towed array. The new sonar provides longer detection ranges, rapid localisation of targets without the submarine having to manoeuvre, multiple target tracking with greater accuracy, and the virtual elimination of flow noise striping.

Manufacturer/Contractor
Lockheed Martin, Bethesda, Maryland, USA.

PROPULSION

Specifications
System: Nuclear
Reactor: 1 General Electric S6W pressurised water reactor (PWR)

Steam turbines: 2—38.8 MW (52,000 hp)
Shafts: 1
Propulsor: 1 pump-jet

Auxiliary propulsion: 1 Westinghouse secondary propulsion submerged motor

FURTHER INFORMATION

PROGRAMME

There has been considerable controversy over this programme, a consequence of its enormous cost and the lack of a perceived need (at least to some eyes) for such a sophisticated submarine following the end of the Cold War. Nevertheless, the first of class was eventually ordered on 9 January 1989, followed by the second of class on 3 May 1991. The third was funded initially in FY92, but in January 1992 it was proposed that all funding for the second and third should be cancelled and long-lead work was suspended on 14 February of that year. Work on *Connecticut* (SSN-22) was, however, restarted on 17 June 1992 and funding for SSN 23 was again requested in the FY96 budget.

Although some of the delays have been caused by budgetary problems, some of the delay (and resulting additional costs) in construction of SSN 21 itself was due to problems in welding the pressure hull.

The cost of SSN-21 alone is estimated to be some $2.4 billion, but even so there have been cost overruns, no less than $56 million in 1993, for example, while a GAO report listed some $223 million as being due to the US Navy for 'late or unsuitable government-furnished design data.'

In addition, it is estimated that over a billion dollars have been allocated for research and development including the S6W reactor system.

DESIGN

Newport News Shipbuilding is responsible for the design of SSN 21, while General Dynamics (Electric Boat Division) is carrying out construction. SSN 21 will have more weapons, achieve a higher tactical speed, be fitted with better sonars, and possess an overall ASW mission effectiveness 'three times better than the improved 'Los Angeles' class' according to the navy. These submarines will also be able to serve as SIGINT and COMINT platforms.

The length:beam ratio is smaller than in the 'Los Angeles' class in order to improve manoeuvrability. In addition, the forward hydroplanes are retractable, there will be an additional pair of stern fins, and a British-style pump-jet propulsor is fitted to enhance silent operation. These and other internal measures result in a quoted 'silent' speed of 20 knots.

There are no external weapon launchers, as in the improved 'Los Angeles' class, but the designers have been able to use the internal space in such a way that the hull will accommodate no less than 50 torpedoes or up to 100 mines.

Facilities for special forces are to be improved in the third of class (if it is actually built), with the torpedo magazine reconfigured to accommodate 50 special forces and a larger escape chamber for locking out. These changes may be retrofitted in due course to the first two of the class.

Full acoustic cladding is fitted.

THE FUTURE

All that can be said with certainty is that two of these SSNs will be completed and that a third is probable, but by no means definite, and that will be the end of the SSN 21 line. The SSN 21 class will almost certainly be the most capable attack submarines ever built, but their cost is so great and the operational requirement in the post-Cold War scenario so indeterminate that even the richest and most powerful nation is baulking.

ATTACK SUBMARINES, DIESEL-ELECTRIC POWERED (SSK)

INTRODUCTION

There are currently 373 diesel-electric submarines in service with 42 navies and nowhere is the strategic importance of these boats more clearly illustrated than in recent US Department of Defense documents. One of these clearly identifies the threats such submarines pose to the movements of US Navy task groups: '...as submarine technologies continue to improve,' the document states, 'the danger lies in the proliferation of these formidable capabilities into the hands of nations whose interests or actions may be hostile to the United States and its allies'.

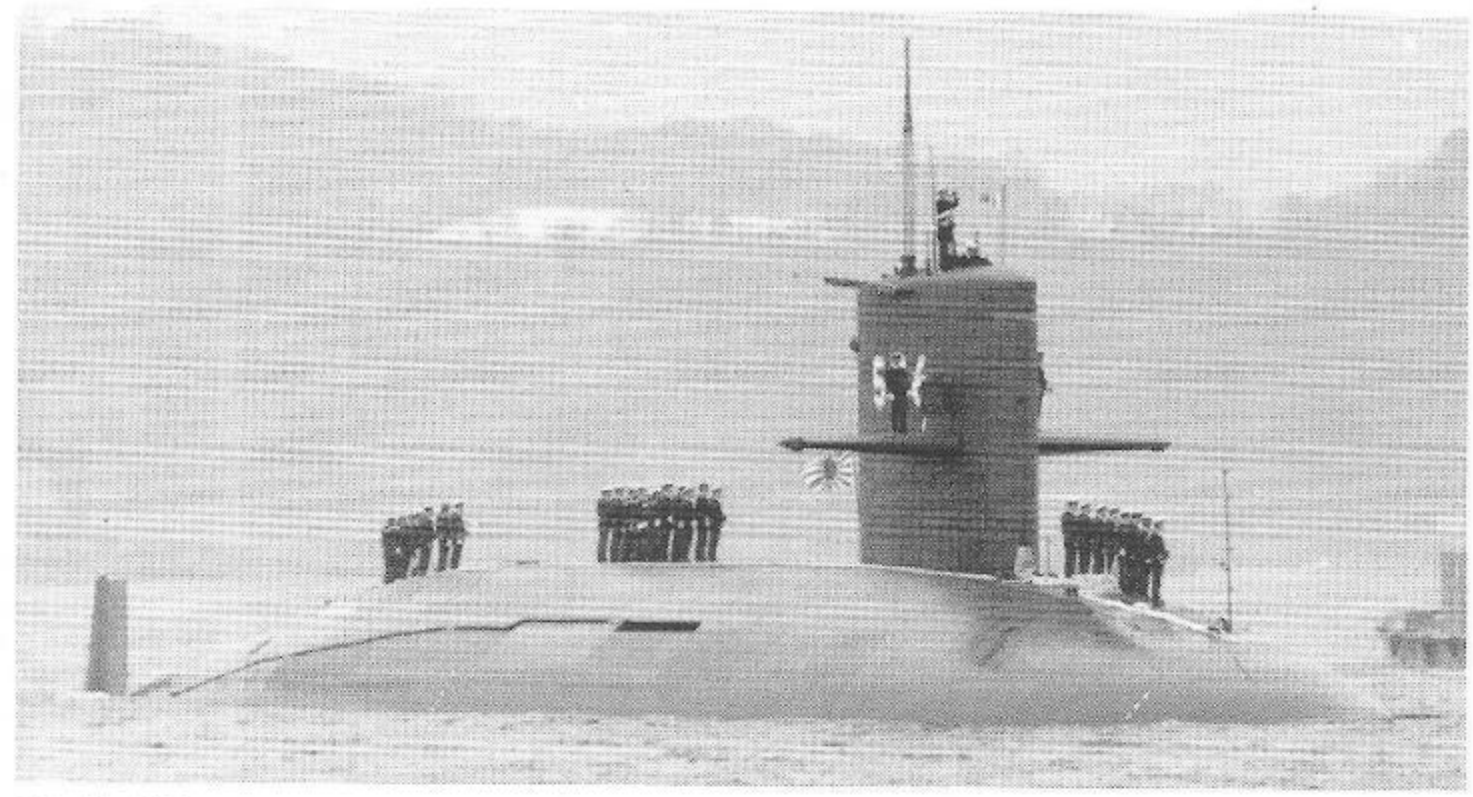
The smaller navies have been quick to grasp this point, too, seeing the submarine as a weapon with a power and strategic flexibility unequalled by other maritime systems. Thus, a small navy, needing to exercise real power in its littoral waters, and particularly in choke points, would be better advised to choose a submarine than almost any other type of warship. This strength of the submarine is being greatly enhanced by the advent of non-nuclear air-independent propulsion systems, which will increase their tactical effectiveness and make it even more difficult for anti-submarine warfare forces to find them. There is, however, no single leading system at the moment and the different systems currently available are described separately.

Operating submarines will always be hazardous, since the ocean depths are inherently hostile to human beings. It is worth noting, however, that such operations have become progressively safer and, while there will never be any room for complacency, the advent of sophisticated and accurate sensors have made submarine accidents relatively rare.

CURRENT FLEETS

The US Navy, which leads in almost every other maritime field, has long since abandoned diesel-electric submarines and, despite recent suggestions that they might be of value in littoral operations (because some claim that the water might be too shallow for SSNs) there seems to be little real prospect of them returning. The UK has similarly ceased operating diesel-electric submarines, as will France once the current boats reach the end of their normal operational lives. Russia, however, despite a large SSN fleet and growing financial pressures, continues to operate a relatively large number of diesel-electric submarines. China is still building up its SSN fleet and will continue to operate a large fleet of diesel-electric boats for many years to come, posing a threat through sheer weight of numbers rather than through technical excellence, at least for the next few years.

The remainder of the diesel-electric submarines are spread around the world — see Table I — with the majority of operators in Europe, although the number of submarines in Asian navies is virtually the same as in European navies, while the number of Asian operators is set to increase over the next few years.



Okishio *(SS 576) is one of a series of Japanese submarines which are among the finest diesel-electric boats in the world, but are not available for export* (H & L van Ginderen Collection)

MARKETS

Asia

Various factors are combining in Asia to create a good market for submarines. The countries' economies are booming, and virtually all trade, whether imports of oil or exports to the West, passes by sea. The area also has a remarkable number of choke points such as the Straits of Malacca, the various straits between the Indonesian islands (Sunda, Lombok, and so on) and the Bashee channel between Taiwan and Luzon. Above all, however, there looms the problem of the South China Sea and the disputes over ownership of the various islands, islets and reefs. All these tend to canalise maritime movements rendering vessels liable to submarine attack as they approach or depart from the choke points.

China

It was thought that China considered itself to be self-sufficient in submarine design and manufacture, but the order for Russian Kilos shows that nationalism is not incompatible with pragmatism.

Indonesia

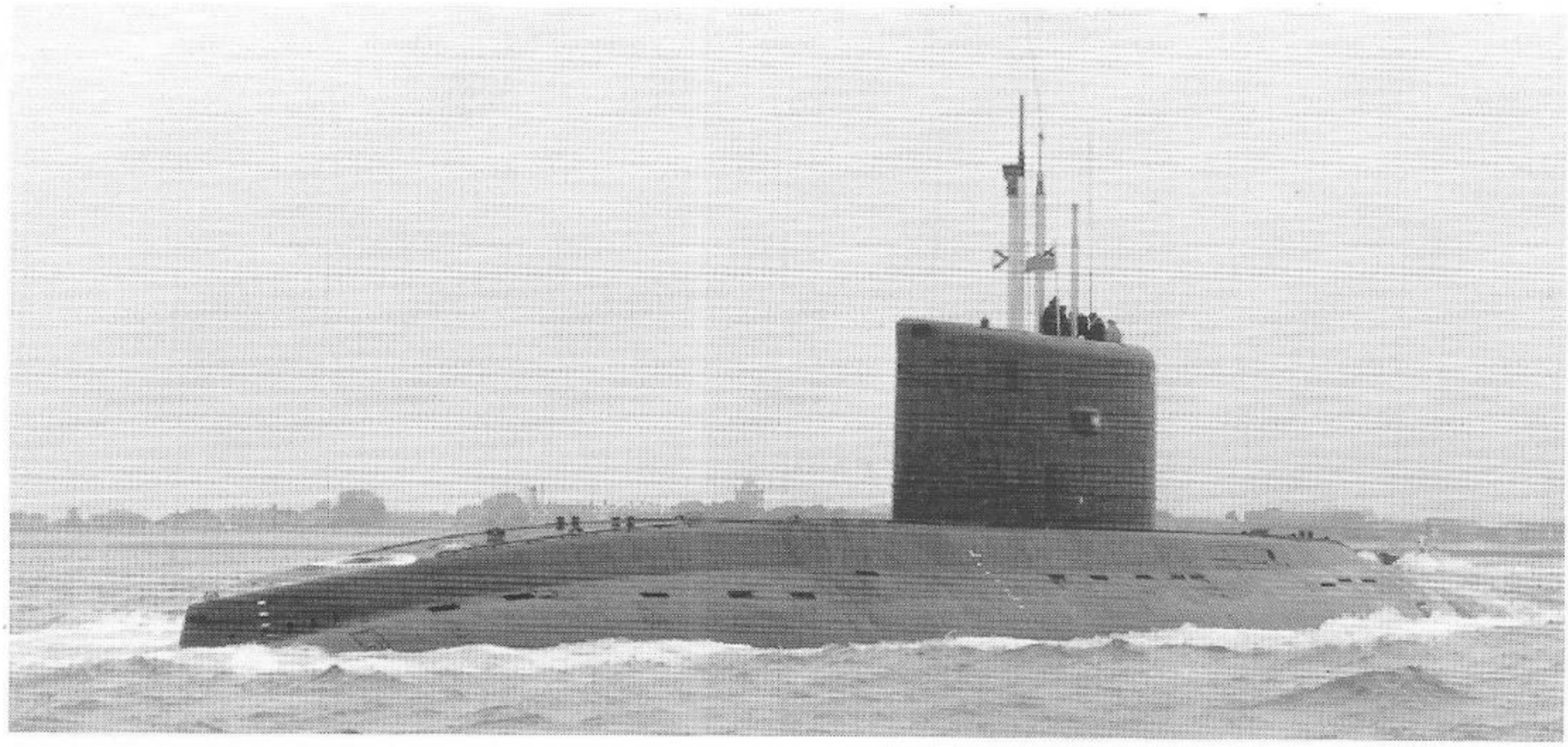
Indonesia is seeking to expand its submarine arm, which has operated two German Type 209/1300s since 1981. Despite reports that a contract had been signed for two Type 209/1400s, however, no order has been placed, and the Netherlands has offered either two new 'Moray' class boats or the two 'Zwaardvis' class now for sale.

Japan

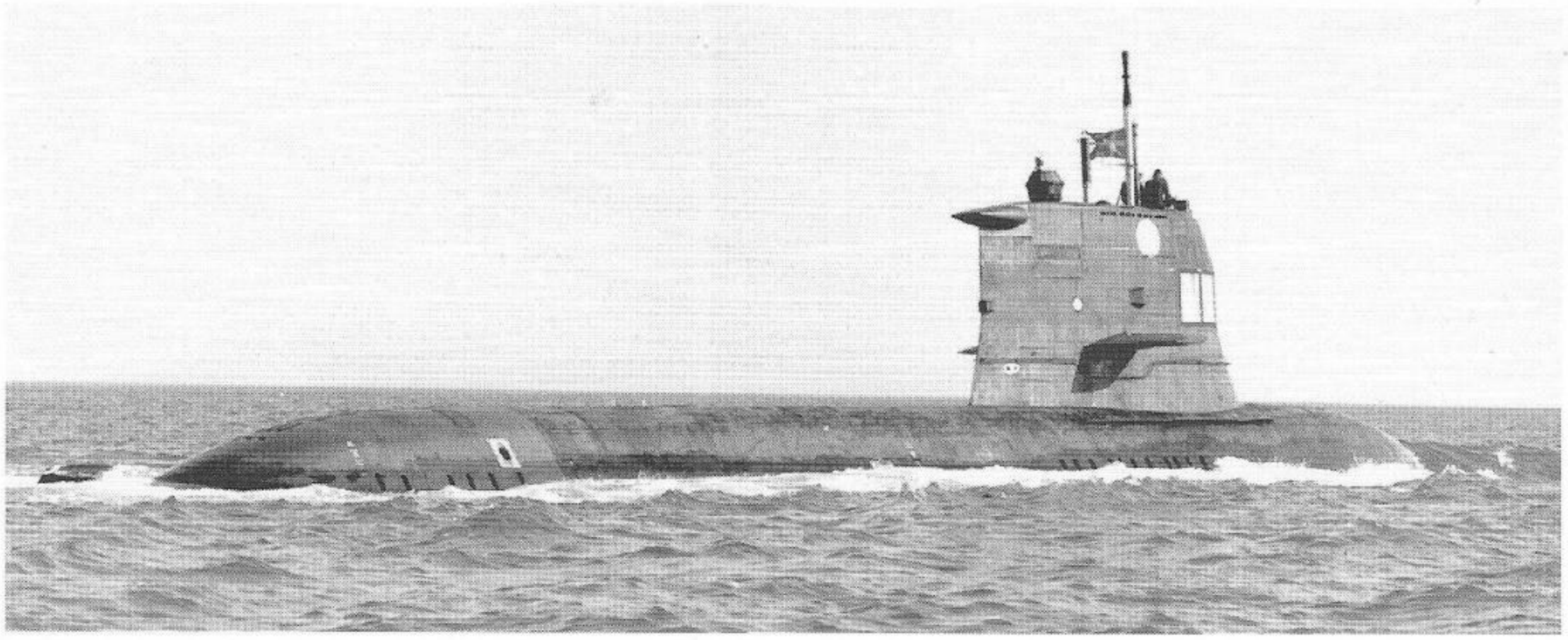
The Japanese Maritime Self-Defense Force has one of the largest diesel-electric fleets, with the individual submarines combining combat capability with modernity. A lot of the equipment and weaponry is either purchased from abroad or produced in Japan under licence, but the overall design and construction of the submarines is exclusively Japanese, with industry geared to meet the JMSDF's demands.

Malaysia

The Malaysian Navy is known to have a requirement for a number of submarines, but the programme has, on several occasions, failed to get funded. In the late 1980s, the RMN was keen to buy a 'Draken' class boat from Sweden to gain experience of submarine operations, but the deal fell through. It is reported that the Malaysian Government is keen to buy from a British yard, which suggests that they would either buy one or more of the redundant Upholders or they would buy new-build boats from VSEL. All that VSEL has on offer



The PLA-N has bought a number of 'Kilo' class submarines from Russia and more are being built in China under licence. They will have a major impact on the naval balance in Asian waters (H & L van Ginderen Collection)



A 'Sjöormen' class submarine has been bought by the Singapore Navy to learn about submarines and to help define the operational requirement (H & L van Ginderen Collection)

are either the Moray (in association with RDM) or a development of the Type 2400.

Singapore

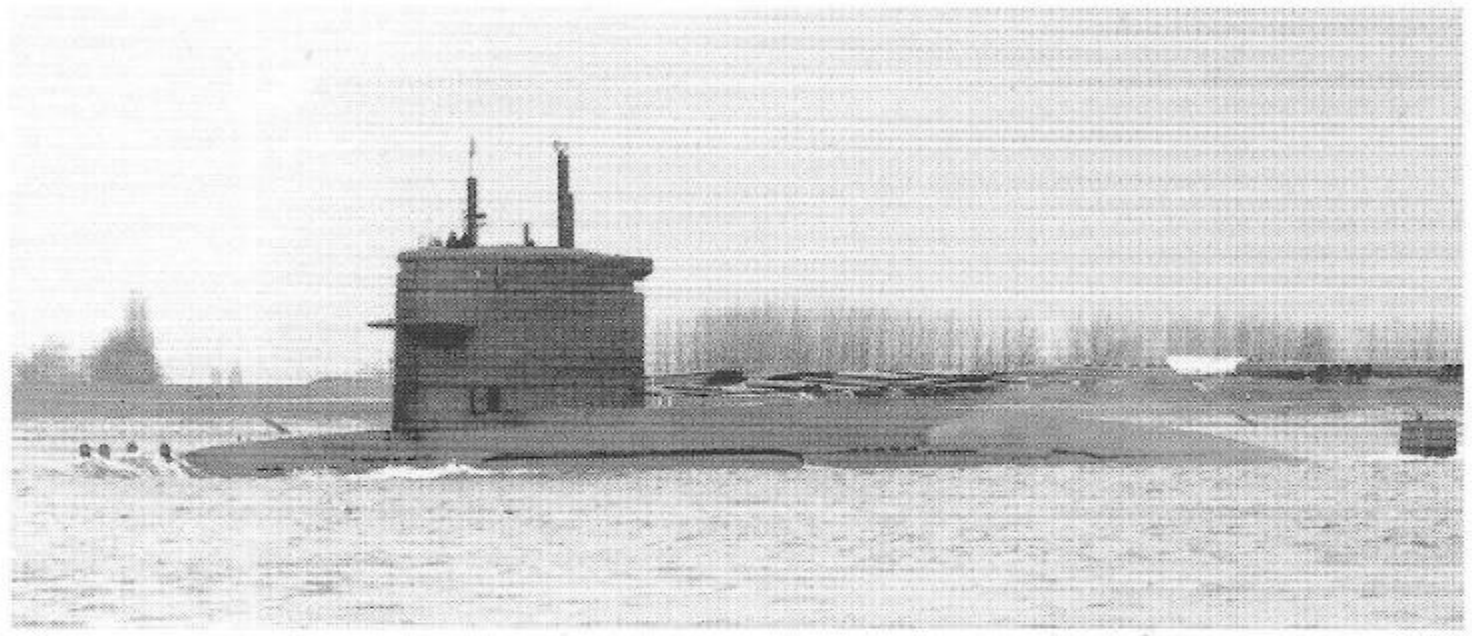
The Singapore Navy has been considering raising a submarine arm for some time and decided, very sensibly, to accumulate some practical experience before deciding on the way ahead. Several possibilities were explored, including the lease of one, possibly two, Type 206 submarines from Germany, and the provision of an extended training course by the Indian Navy using one of its 'Foxtrot' class boats. The German plan is reputed to have fallen through because the RSN demanded performance guarantees for the Type 206s which, due to the age of the boats, the Germans were unwilling to give. The Indian plan was also discarded. In the event, the RSN has turned to Sweden and bought the redundant *Sjöbjörnen,* which is being refurbished prior to delivery. Following operational experience, and with full government/builder support from the Royal Swedish Navy and Kockums in developing all aspects of creating and operating a submarine flotilla, the Singapore Navy will formulate its operational requirement. It should be noted that the Singapore Navy already has experience of working with the Swedes in the Landsort MCMV programme.

Taiwan

The Taiwan Navy has long planned to acquire up to 12 patrol submarines, but has been constantly blocked by pressure on potential vendor governments from the Chinese Government in Beijing. Efforts to buy Type 209 submarines were frustrated in January 1993 by Germany's Federal Security Council, and attempts to buy Agostas from France were also prevented. In February 1992 the Netherlands Government also refused permission to build new submarines in Dutch shipyards but the project was reviewed in 1993 and Dutch shipbuilder RDM may be allowed to deliver sections for assembly in a third country. Taiwan is also known to be interested in the two surplus Dutch Navy 'Zwaardvis' class submarines awaiting a buyer.

Thailand

Thailand is conducting a major naval expansion, involving the purchase of destroyers and frigates, as well as the first-ever aircraft carrier to be operated by a South-East Asian navy. This plan includes submarines, but it



Taiwan operates two of the modified 'Zwaardvis' class boats and is scouring the world markets for more submarines (H & L van Ginderen Collection)

was only in early 1995 that the proposal was given formal approval, although some elements of the finance package have yet to be approved by the Treasury. The plan is believed to involve two or three submarines of an advanced design, which must be able to operate in the Indian Ocean, South China Sea and the Gulf of Thailand, all at a total programme cost of $690 million (Baht17 billion.) A senior naval delegation is known to have visited Sweden in 1995 and some Thai officers did a 6-week submarine course in the Netherlands in 1993.

EUROPE

Denmark and Norway

The Danish submarine fleet consists of some very elderly submarines, for which replacements are needed by 2010 at the latest. Half of Norways's fleet consists of the relatively modern 'Ula' class, but the remainder are elderly Type 207s, virtually identical to those operated by Denmark and in need of replacement in a similar timeframe. Both Germany and Sweden are keen to attract orders from these two countries. Germany is offering the Type 212 and, having supplied submarines to both countries for many years, it has a good working relationship with them. Sweden is offering the Submarine 2000 and, although it has not exported submarines to either country before, it is promoting the new design as a 'Nordic' solution.

Finland

For many years the Treaty of Paris prevented Finland from buying and operating a number of types of weapons including submarines and torpedoes. That treaty has, however, now been abrogated and Finland is presently considering establishing a submarine arm, which would, presumably, operate small submarines suitable for the special conditions found in the Baltic.

Italy

Since it restarted submarine production in the 1950s, Italy has followed a policy of producing a series of small classes of two submarines each, thus ensuring that the technology and production capability is kept alive. These designs have been entered in some foreign competitions, but with no success to date. The latest in this sequence would have been Project S90, but this was cancelled in 1994, leaving the navy with a choice between either a new, 2,000 tonnes displacement, lengthened version of the 'Sauro' class, or the German Type 212 with air-independent propulsion (AIP). In the event, the latter has been selected.

Portugal and Spain

Both Portugal and Spain operate ageing 'Daphne' class submarines, which are now in urgent need of replacement. Various designs are under consideration by both navies, including the French Scorpene, and it may be significant that Bazán has offered that design in a number of recent competitions. Spain is also known to be looking at various AIP systems, although, again, no decision has been reached.

MIDDLE EAST

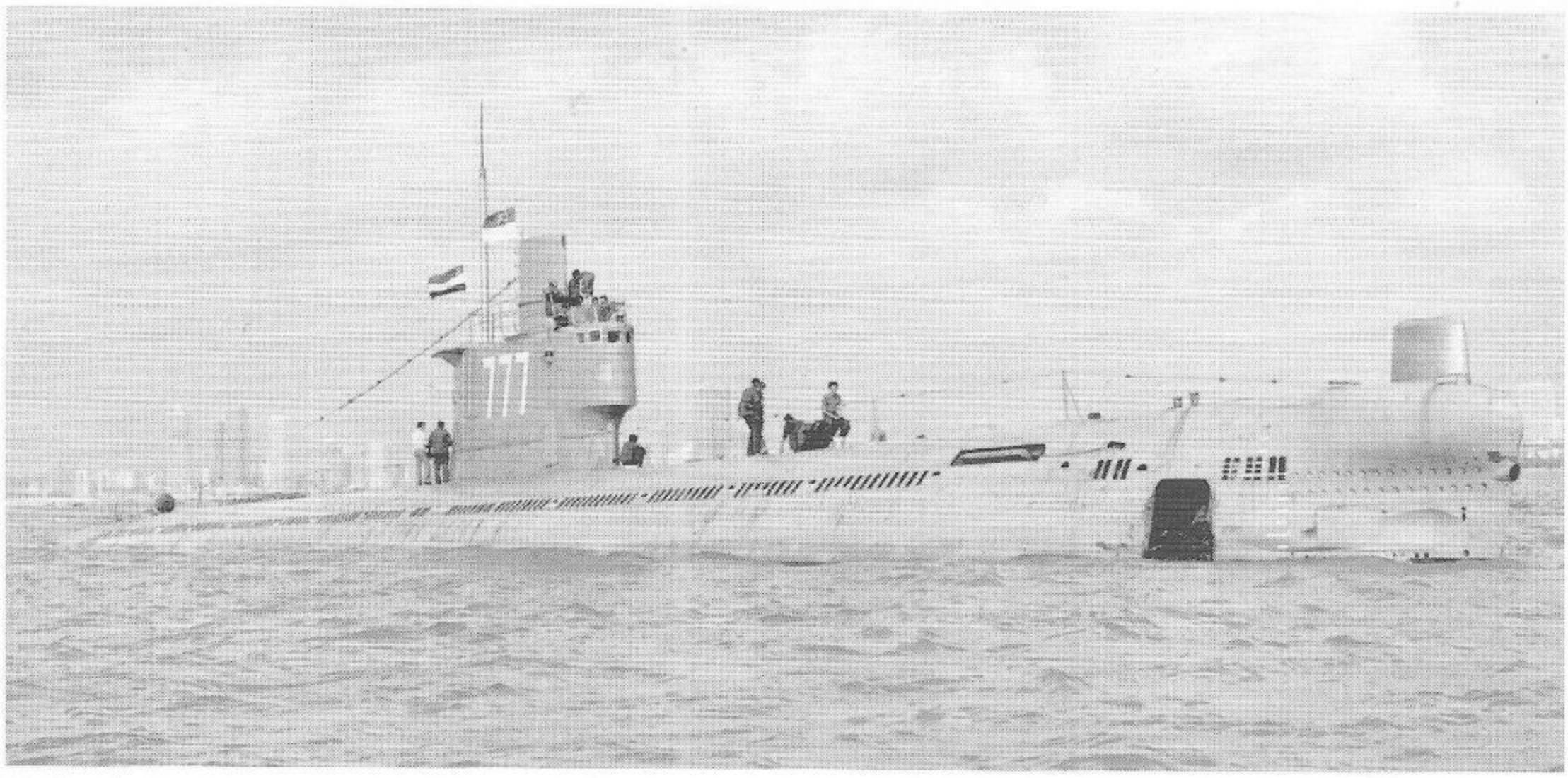
Israel

Israel is meeting its current needs with three 'Dolphin' class submarines which are being built in Germany to a derivation of the German Type 212 design.

Egypt

The Egyptian Navy has long wished to expand its submarine arm, but has been limited by funding rather than by any strategic or political problems. The somewhat

Gugliemo Marconi *(S 521) is likely to be one of the last purely Italian-designed and built submarines as the next class for the Italian Navy will be licence-built German Type 212s* (H & L van Ginderen Collection)



The Egyptian Navy has a number of 'Romeo' class submarines, a dated design, but still worth a major rebuild in US yards (H & L van Ginderen Collection)

outdated Chinese-supplied Romeo hulls are currently being updated, which can, at best, only be an interim solution.

Saudi Arabia

Saudi Arabia has a long-standing requirement for submarines, but, as yet, nothing to show for it. Various designs from France, Germany, Italy, Netherlands, Sweden and the UK were considered some 5 to 7 years ago, but the project was then shelved. The project is still on a low priority and in view of the time that has passed, when it is restarted, designs and industrial factors will have to be examined afresh.

SUB-SAHARAN AFRICA

South Africa

The only navy south of the Sahara to have shown an interest in submarines is South Africa, which lies astride the Cape of Good Hope shipping route. The South African Navy (RSAN) took delivery of three 'Daphne' class submarines from France in 1970-71, but its follow-on order for two of the larger 'Agosta' class submarines was not met, due to the imposition of the UN arms embargo. The three 'Daphne' class boats have been upgraded several times, the latest giving them a life extension to 2005, by which time they will be no less than 35 years old. With the lifting of the arms embargo first priority has been given to corvettes, but once that programme is under way it seems very likely that the next programme will be the replacement of the three 'Daphne' class submarines and it is known that feasibility studies have been done to evaluate possible replacements. The requirement would be for one-for-one replacements of the Daphnes, with the new boats being built abroad, relatively small in size (say, under 2,000 t submerged displacement) and relatively unsophisticated. AIP might be fitted if it was inexpensive and conferred sufficient tactical advantages.

THE AMERICAS

North America

Now that the plan to operate SSNs has been finally abandoned, Canada remains faced with the original problem of replacing the three 'Oberon' class diesel-electric boats, which, as with most such Canadian projects is proving to be a lengthy process. The four surplus British Upholders have been offered to Canada, either 'as-built' or with an additional section containing an AIP system, but they have been turned down.

The Caribbean

The only Caribbean navy with a submarine arm is Cuba and all these boats are reported to be in a very poor condition. In view of the country's bad economic state and its abandonment by Russia, it seems highly improbable that these boats will be either refurbished or replaced.

South America

There are seven South American navies with submarine arms. All operate German Type 209s, although Brazil and Chile also have elderly British Oberons and Argentina has two German TR-1700s. Both Brazil and Chile are seeking replacements for their Oberons, and some of the others are seeking either to expand their submarine arm or to replace the older of the Type 209s.

INDUSTRIAL

Overcapacity

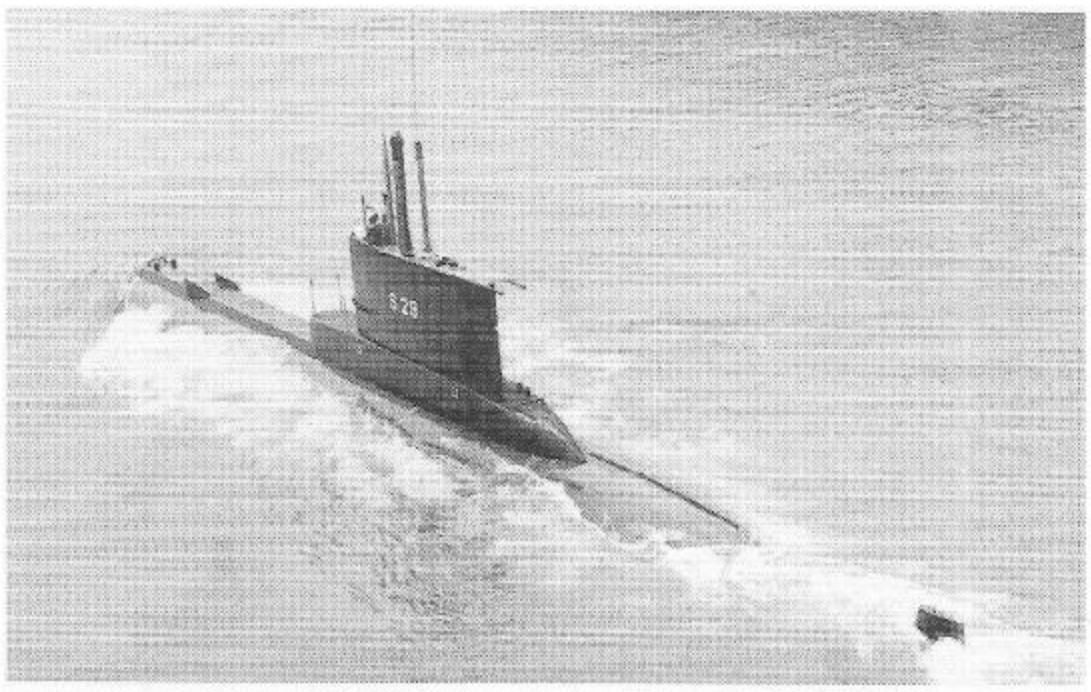
The conventional submarine scene cannot be discussed properly without looking at several industrial issues. In Western Europe there are active production facilities in France (DCN), Germany (HDW and TNSW), Italy (Fincantieri), Sweden (Kockums) and Turkey (Golcük) all of which are currently producing diesel-electric submarines, while there are also dormant capabilities in Denmark, the Netherlands, Spain and the UK.

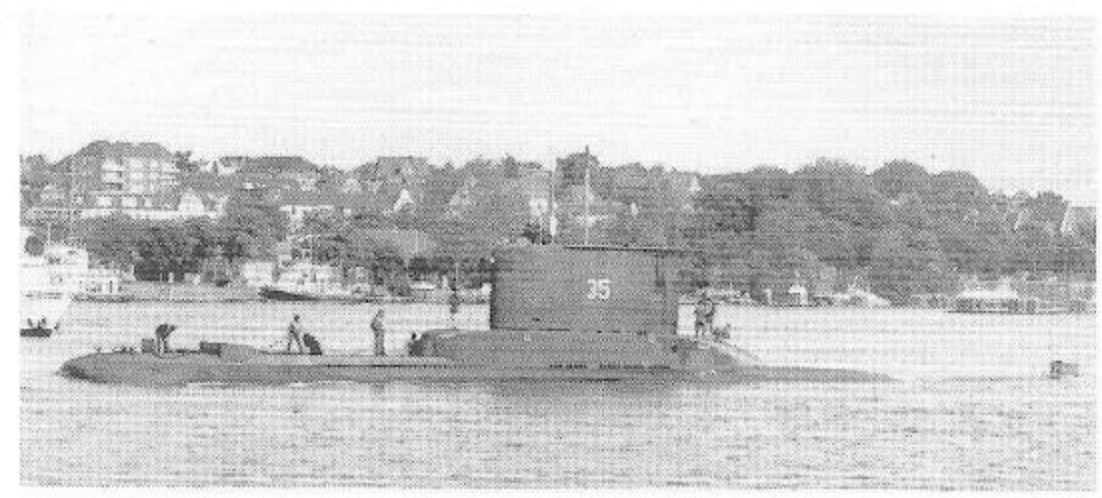
Many export sales include a requirement for the vendor to set up a production facility in the country making the purchase, and, after the early submarines are produced in the vending country, later submarines in the order are produced in the purchasing country. This has worked well in some cases, eg, Australia, Brazil and Turkey, but has not worked very well in other cases, where the programmes have been subject to lengthy delays. Where it has been successful, such a move has certainly benefited the receiving country in the short term, but, as the global submarine market is, at best, relatively small, the result has only been to move the problem of overcapacity from one part of the world to another. The experience of Australia is of particular interest, where the Australian Submarine Corporation (ASC) has certainly been very successful in meeting the order for six 'Collins' class submarines, but is now faced with finding export orders to keep the yard in business.

This industrial problem is exacerbated by the fact that modern submarines are increasingly reliable and have ever longer lives — 30 years and more. Coupled with generally smaller fleets this results in yet less work for the yards.

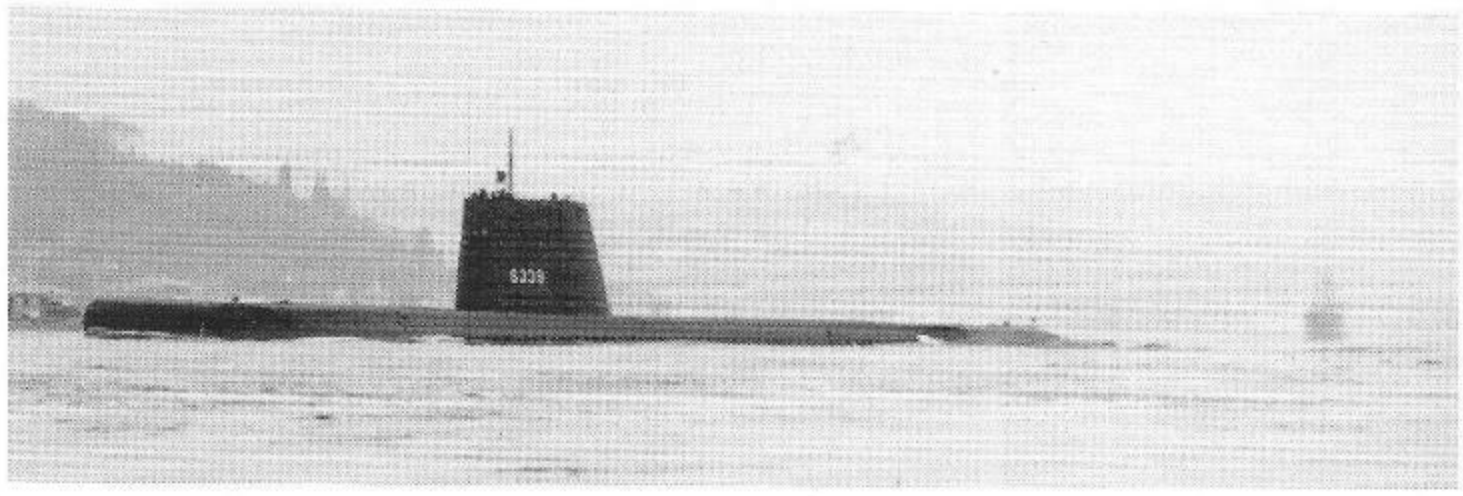
The USA and non-nuclear submarines?

Another factor is the position of the USA. The last operational diesel-electric submarines to be produced in the US were the three 'Barbel' class boats which were launched in 1959; since then the US submarine industry has concentrated exclusively on nuclear-propelled submarines. This left the rest of the world market open to others, particularly the Europeans, a situation which was enhanced by the desire of many countries not to buy from 'Communist' countries such as the USSR and China. This was exploited by the European yards until the end of the Cold War, but Russia and China are now entering the export markets as well. In addition to this,





The most significant diesel-electric submarine is the German Type 209. 50 have been ordered by many navies and production continues as the design is continually updated. The Type 209 has found a strong market in South America as illustrated by Columbian Tayrona *(SS 29) (left) and Peruvian* Islay *(S 35)* (H & L van Ginderen Collection)



Despite their age there are 16 ex-US Navy submarines still in service, although their numbers are dwindling fast (H & L van Ginderen Collection)

however, the business generated by the US Navy's requirements for SSBNs and SSNs is no longer sufficient to keep two major US yards in production; indeed, orders are now at an all-time low and the yards are looking for alternative work in order to survive. The global diesel-electric market is an inevitable target, either producing third-party designs, or, as seems more probable, producing their own. Such a move could only be to the detriment of both European and recently established Third World yards.

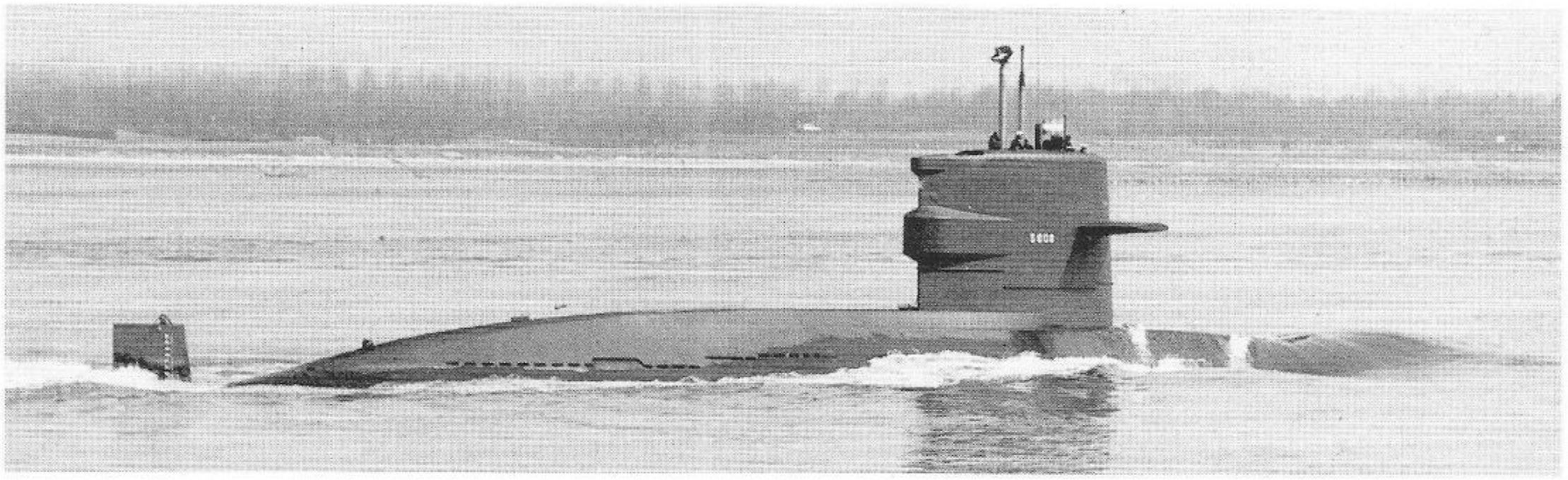
National procurement policies

National procurement policies also play a significant role, with two general approaches being used. One is the 'slow but steady' approach where individual classes are kept small, and improvements to design and capability are incremental rather than revolutionary. The result is a steady work throughput in the shipyard and the maintenance of a national design and production capability. Such a practice has been followed by Italy, Japan and Sweden with great success.

The alternative may be termed 'all or nothing' approach, in which orders are placed for relatively large classes over a short period, interspersed with long gaps during which no submarines are ordered at all. This results in a loss of capability in the design bureaux and the yards, which may even go out of business altogether unless the level of work is maintained either by refit work or by export orders. This approach has been followed by the Netherlands and the UK where there have been long gaps between classes, and insufficient export orders to maintain the flow of work. As a result, the number of submarine-capable yards dropped from two to one in the Netherlands, while in the UK, the four in business in 1960 reduced to two in 1990, and to one in 1994. A similar problem has beset the French and Spanish where the last submarine was completed in 1986. Indeed, even in Germany, the submarine industry is sustained by its export and modernisation business, since orders from the German Navy are very spasmodic, with a 22-year gap between the completion of the last of the Type 206s in 1974 and laying down the first of the Type 212s.

The surplus submarines

There is an additional, short-term problem in that there is currently a small number of second-hand submarines



One of the factors currently distorting the diesel-electric market is that there are a number of very modern, second-hand submarines available including two of these Dutch 'Zwaardvis' class boats (H & L van Ginderen Collection)

TABLE I: SUBMARINE OPERATORS AND FLEETS — 1996

Europe (16)		Middle East (4)		Africa (3)		Asia (9)		North/South America (9)	
Bulgaria	2	Egypt	6	Algeria	2	Australia	4	Canada	3
Denmark	5	Iran	2	Libya	4	China	77	Cuba	3
France	7	Israel	3	South Africa	3	India	18	Argentina	4
Germany	18	Syria	1			Indonesia	2	Brazil	5
Greece	8					Japan	18	Chile	4
Italy	8					Korea-North	22	Colombia	2
Netherlands	4					Korea-South	3	Ecuador	2
Norway	12					Pakistan	6	Peru	8
Poland	3					Taiwan	4	Venezuela	2
Portugal	3								
Romania	1								
Russia	44								
Spain	8								
Sweden	12								
Turkey	17								
Yugoslavia	5								
	157		12		9		154		33

Total numbers of navies operating submarines: 42
Total number of diesel-electric submarines in service: 367

on the market, for which the present owners are keen to find buyers. Of these, perhaps the most significant are the four British 'Upholder' class submarines, completed between 1990 and 1993, and which served only briefly before being taken out of service and offered for sale. They are very sophisticated, are built and equipped to the highest standards, and have been used for a very short period.

There are also two Dutch 'Zwaardvis' class submarines, which entered service in 1972 and were decommissioned in 1994/95. These, too, are sophisticated boats and were recently refitted and modernised.

The incomplete Argentine TR-1700s are also up for sale, comprising two partly completed hulls and two kits of parts. Several European dockyards are interested in buying these in order to produce two fully working submarines, but need to find a customer first.

Sweden used to avoid exporting defence equipment, but since the end of the Cold War the country has proved more amenable to sales. An old 'Draken' class submarine was offered for sale to both Malaysia and Singapore some years ago, while one Sjöormen has recently been sold to Singapore, and Finland is reported to be interested in another.

It also is possible that the four French Navy Agostas may be put on the market when they are decommissioned in about 2002. At that time they will be 25 years old, but there are a number of submarines in operation today (such as the ex-US Navy Guppys) which are considerably older than that.

TABLE II: SUBMARINE FLEETS BY CLASS — 1997

Country of origin	Class	In service	Number in service	Building	Entered service	Comment
Australia	Collins	Australia	1	5	1995-99	Joint Australian/Swedish design
China/Russia	Romeo	Bulgaria	2		1972-86	Questionable serviceability
		China	65		1960-82	Many in reserve
		Egypt	6		1966-83	
		North Korea	22		1973-75	Not all may be in service
		Syria	1		1957-60	Questionable serviceability
China/Russia	Golf	China	1		1966	
China	Wuhan	China	1		1995	
China	Ming	China	10	1	1975-	
France	Agosta	France	4		1977-78	
		Pakistan	2	3	1979-90	
		Spain	4		1982-86	
France	Daphne	France	3		1964-70	
		Pakistan	4		1969-70	
		Portugal	3		1967-69	
		South Africa	3		1970-71	
		Spain	4		1973-75	
Germany	TR 1700	Argentina	2	2	1984	2 building, may not be finished
	Type 205	Germany	2		1966-69	Now used as auxiliaries
	Type 206/206A	Germany	18		1973-75	
	Narvhalen	Denmark	2		1970	
	Type 540	Israel	3		1977	
	Type 207	Norway	6		1964-67	
	Type 207	Denmark	3		1964-65	
	Type 209/1100	Greece	4		1971-72	
	Type 209/1200	Argentina	2		1974	
		Colombia	2		1975	
		Greece	4		1979-80	
		South Korea	3		1993-	
		Peru	6		1975-83	
		Turkey	6		1975-89	
	Type 209/1300	Chile	2		1984	
		Ecuador	2		1977-78	
		Indonesia	2		1981	
		Venezuela	2		1976-77	
	Type 209/1400	Brazil	2		1989	
		Turkey	2	2	1994-95	

TABLE II—continued

Country of origin	Class	In service	Number in service	Building	Entered service	Comment
Germany—continued	Type 209/1500	India	4		1986-94	
	Type 210/Ula	Norway	6		1989-92	
	Type 212	Germany		4	2000	
		Israel		2	1997	Modified Type 212
		Italy		2	2000	
Italy	Sauro	Italy	4		1980-89	
	Improved Sauro	Italy	4		1992-95	
Japan	Uzushio	Japan	2		1971-78	
	Yuushio	Japan	10		1980-89	
	Harushio	Japan	6		1990-95	
	Improved Harushio	Japan		3	1997-99	
Netherlands	Zwaardvis	Netherlands			1972	2 awaiting sale
	Hai Lung	Taiwan	2		1987-88	
	Walrus	Netherlands	4		1990-94	
	Kilo	Algeria	2		1987-88	
		China	1	4	1995-	
		India	8		1986-91	
		Iran	2		1992-93	
		Poland	1		1986	
		Romania	1		1986	
		Russia	24		1980-93	
	Foxtrot	Cuba	3		1979-84	Questionable serviceability
		India	6		1970-74	
		Libya	4		1976-83	
		Poland	2		1987-88	
		Russia	2		1957-68	
	Tango	Russia	18		1972-82	
Sweden	Vastergotland	Sweden	4		1987-90	
	Nacken	Sweden	3		1980-81	
	Sjöormen	Sweden	5		1968-69	
		Singapore	1		1996	
UK	Upholder	—			1989-94	Four awaiting sale
	Oberon	Australia	3		1967-78	
		Brazil	3		1973-77	
		Canada	3		1965-68	
USA	Abtao	Peru	2		1954-57	
	Guppy II	Taiwan	2		1945-46	
	Guppy IIA	Turkey	5		1944-45	
	Guppy III	Turkey	7		1944-45	
	Tang	Turkey	2		1952	
Yugoslavia	Heroj	Yugoslavia	2		1968-70	Questionable serviceability
	Sava	Yugoslavia	2		1978-82	Questionable serviceability
			371	28		

AIR-INDEPENDENT PROPULSION SYSTEMS

The longer it can remain below the surface, the more effective a submarine becomes, although no propulsion system yet devised provides everything needed by the operator. Nuclear propulsion is nearest to the ideal from the operator's point-of-view, providing a large amount of power for protracted periods, reasonably quietly and efficiently. It is, however, extremely expensive in infrastructure, training and disposal costs, and has a severe political impact; these are factors which, in combination, put it beyond the reach of all but a very few navies.

Other navies have long searched for a system which will provide at least some of the advantages of nuclear propulsion but without the cost and political problems. Lead-acid secondary cells provide a simple and effective answer, using thoroughly well-understood technology, but they have a serious tactical limitation in that the submarine must approach the surface at regular intervals, expose the head of its snort-tube and run its diesels in order to recharge. This 'indiscretion ratio' depends on the tactical employment of the submarine, domestic power consumption (the 'hotel load'), the efficiency of the charging system and the nature of the cells, and will vary between 10 and 25 per cent.

One of the most important of contemporary developments in submarine technology is the entry into service of viable air-independent propulsion (AIP) systems, which enable a non-nuclear submarine to remain totally submerged without exposing even its snort-tube for up to 14 days and perhaps even longer in some cases. These systems are all either extremely quiet or totally silent, but of those presently coming into service, none is yet able to propel a submarine at a speed greater than 8 knots; indeed, most envisage a speed of no more than about 5 knots. They are, therefore, limited to use during patrols and all require the diesel engine/lead-acid cell combination to be retained for high-speed propulsion.

Designations

A useful means of categorising non-nuclear AIP propulsion systems has been devised by the German submarine design bureau, IKL:

Category A is the 'classic' diesel-electric propulsion system, in which a secondary battery is used to store energy from an air-dependant diesel engine for use for submerged propulsion

Category B is a hybrid, in which an AIP system provides low-speed patrol power, while a Category A system is retained for high-speed operations

Category C is a totally AIP system in which the AIP energy converter either meets the entire power requirement or a secondary battery (charged by the AIP system) is retained for high-power/high-speed requirements.

One of the features of the Category B systems now being produced is that all are capable of being installed in a virtually self-contained 'plug' which can either be installed in a new hull under construction or can be added to an existing hull during a major refit.

The power requirement

A submerged submarine requires power for two functions: the 'hotel load' and propulsion. The first of these, the 'hotel load', is the totality of the electrical power needed for the operational equipment (for example, computers, sonars and other sensors, pumps, compressors) and for life-support systems (for example, lighting, air conditioning, heaters and refrigerators, carbon-monoxide scrubbers, ventilators and so on). A large part of this 'hotel load' is unavoidable and the power required for propulsion must be met from what remains of the capacity of the power source. A typical figure for 'hotel load' in a medium-sized non-nuclear submarine is some 75-85 kW while a further 65-75 kW will propel the submarine at about 3 to 5 knots. To produce speeds in excess of this means larger or a greater number of power units.

Current position

The health of the AIP position can be gauged by the fact that:

Three navies have AIP submarines on firm order — Germany, Pakistan, Sweden

Five navies have AIP systems under active consideration for their next generation of submarines — Australia, Canada, Italy, Japan, Russia

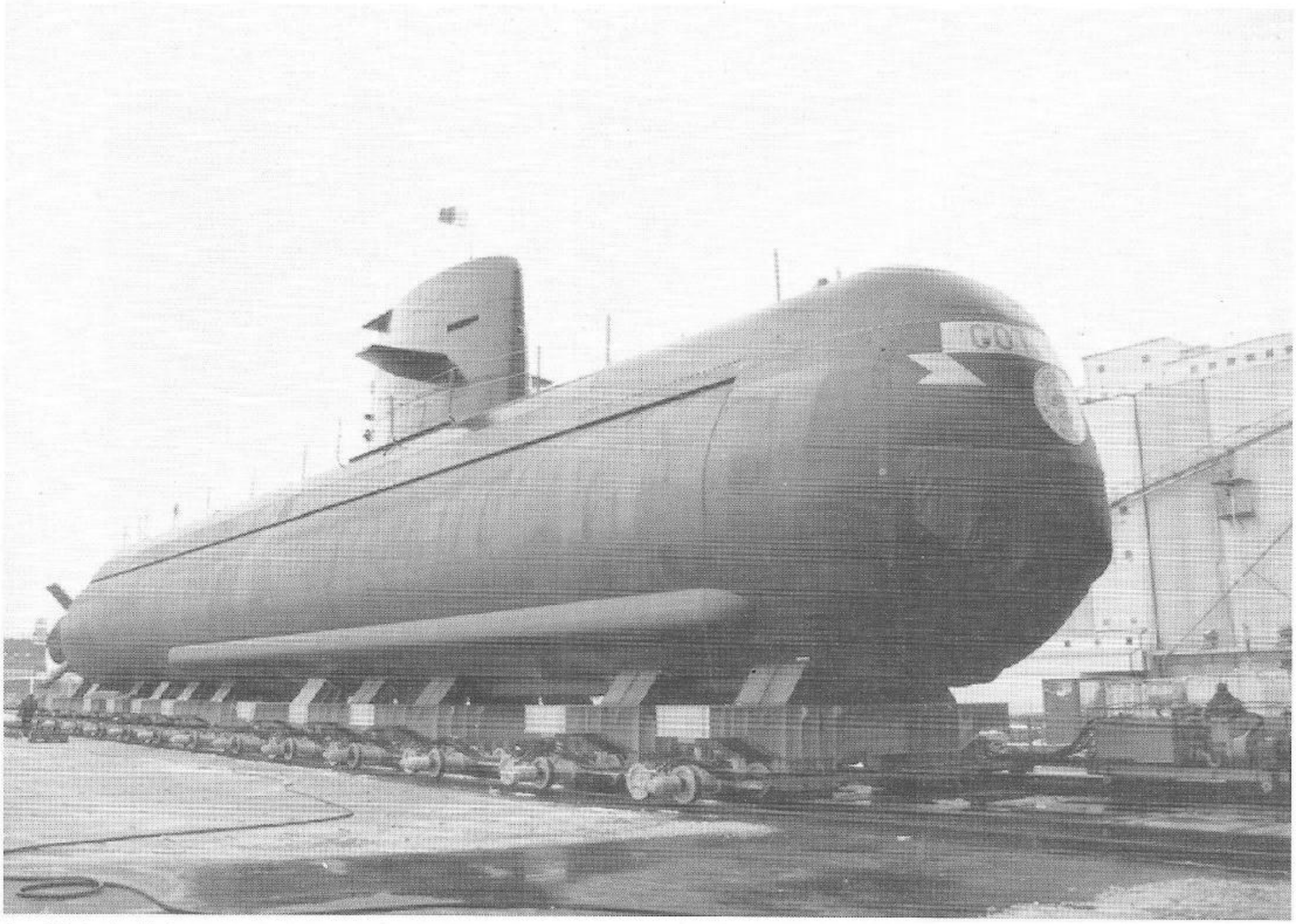
Five companies in four countries have AIP systems on offer, either for installation in new-build submarines or as 'plugs' for insertion in existing hulls — DCN in France; Howaldtswerke and Thyssen Nordseewerke in Germany; RDM in the Netherlands; and Kockums in Sweden.

The earliest non-nuclear AIP system was devised by the German pioneer, Professor Helmuth Walther, in the 1930s. His closed-cycle system was based on the use of hydrogen peroxide (H_2O_2) as an oxidant and was potentially very efficient. It also needed a new hull to take advantage of the power being offered and the effort required to develop the two simultaneously proved too much for German industry during wartime. After the war, Britain, the USSR and the USA all attempted to develop it into a working system, but the Americans and Russians eventually abandoned the idea as too difficult. The British, however, seeing it as a potential alternative to expensive nuclear power, persisted. Walther himself worked at the Vickers yard at Barrow from 1946 to 1949 and two trials submarines appeared in the early 1950s, but the system proved hazardous and HMS *Explorer* earned the ironic nickname of 'Exploder.'

THE GERMAN NAVY FUEL-CELL SYSTEM

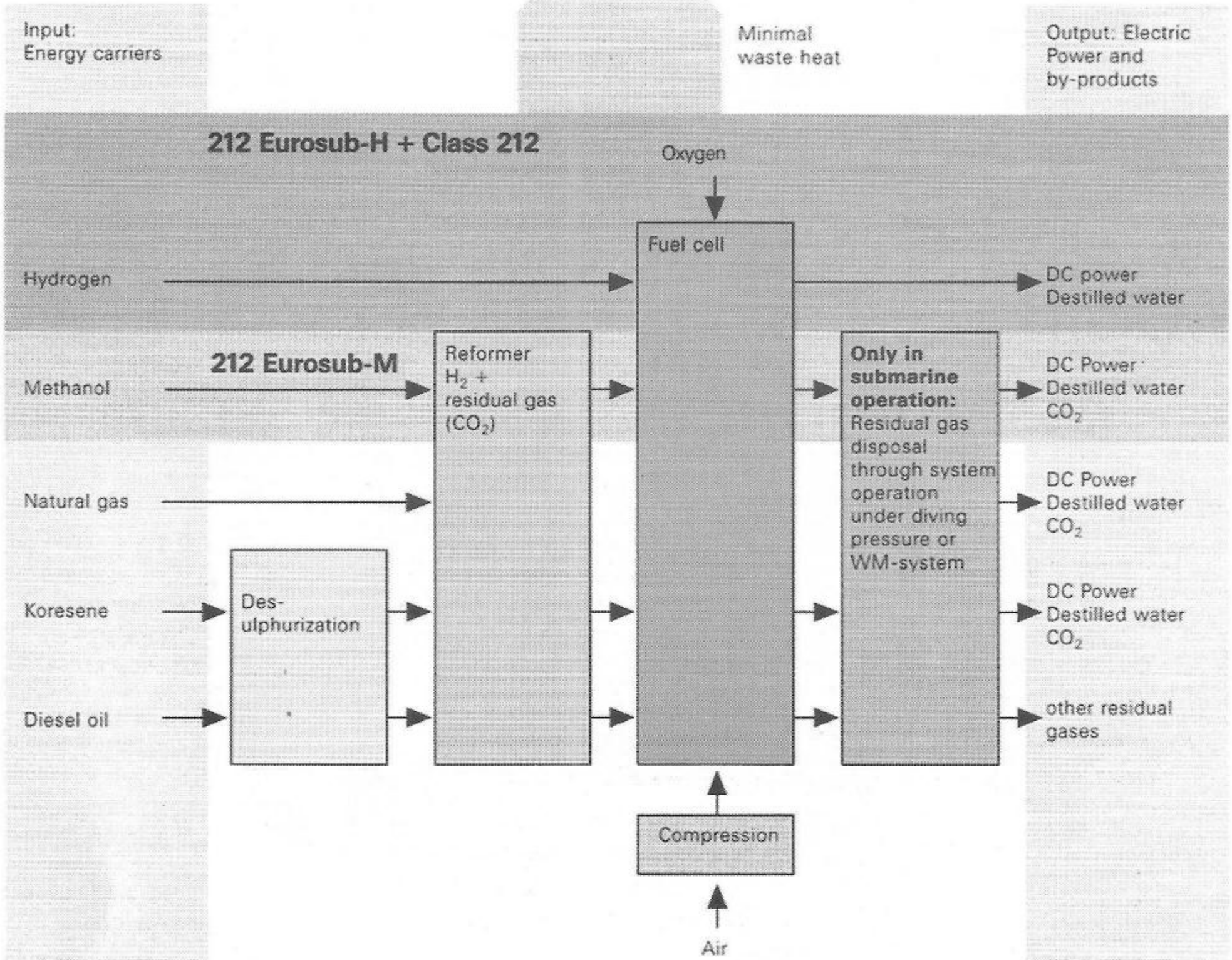
Polymer Electrolyte Membrane Fuel Cells (PEM-FC)

The next class of submarines for the German Navy — the U 212 class — will have a hybrid power installation consisting of a single MTU diesel generator, two groups of 216 sodium sulphide, high-energy secondary cells,



Swedish Gotland is the world's first fully operational submarine to be built with a non-nuclear AIP plant — the start of a very important trend in underwater warfare (Kockums)

1



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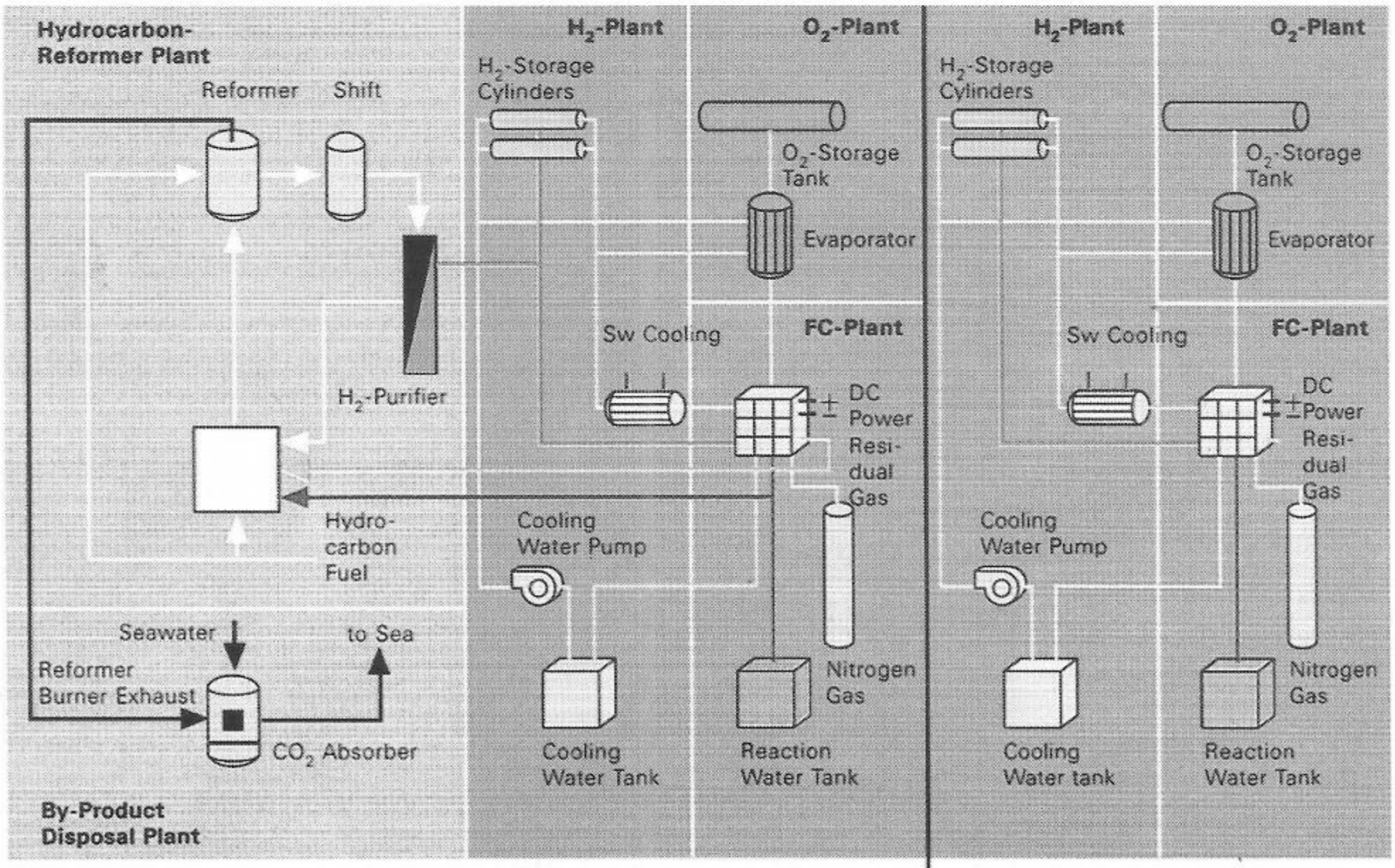


Eurosub-M
Fuel Cell System
Mono System FC

Eurosub-H
Fuel Cell System
Hybrid System
Diesel Generator, FC, Battery

The PEM fuel-cell plant that will power the U 212 class submarines of the German Navy (HDW)

German submarine U-1 (S 180) as converted in 1987 to test the original fuel-cell system (Federal German Navy)

and a group of fuel cells. These Polymer Electrolyte Membrane Fuel Cells (PEM-FC) will produce electric power directly from hydrogen and oxygen with an efficiency of up to 80 per cent, at a temperature below 80°C, and produce less emission of pollutants than other forms of AIP. In addition, and of particular importance in a submarine application, the system is noiseless.

The PEM-FC contains a proton-conducting solid polymer membrane with platinum-catalysed, gas-diffusion electrodes and sheets of carbon serving as current collectors. Apart from producing power, there are additional benefits, since potable water is produced as one by-product, while the fuel cells operate with a minor excess of oxygen (which is needed to lead water away from the cathode) and this is exhausted into the submarine's atmosphere for use by the crew as breathing air.

The efficiency of the fuel cell is greater under partial rather than full load, which means that it can be operated very economically. The cooling unit transfers the reactants to the electrodes, removes heat from the electrodes, removes waste water from the cell and seals the various media from each other. Hydrogen is stored in metal hydride cylinders and the liquid oxygen (LOX) in insulated tanks, both being located between the pressure hull and the outer casing.

Individual fuel cells are arranged in rows, referred to as stacks, with the stacks being grouped into a module, which includes functional and connection components. The module electronics are centrally located on a switchboard. The fuel-cell module is located in a pressure-tight container and maintained under a low-excess pressure of nitrogen.

Depending on requirements, individual fuel-cell modules are connected together in series and/or parallel. In addition, the plant is arranged to permit interconnection of the fuel-cell plant and the battery, so that as the voltage of the fuel cell drops with increasing load (that is, when high performance is needed) the battery can take over to provide power Thus, a brief spurt of high power can be given without generating switching noises.

The fuel-cell installation will allow the Type 212 submarine to cruise on AIP power for over 50 per cent of the mission time, with individual submerged periods of approximately 14 days. At a fuel-cell output of about 300 kW the Type 212 will be able to run at up to 8 knots without recourse to battery power.

Manufacturer/Contractor

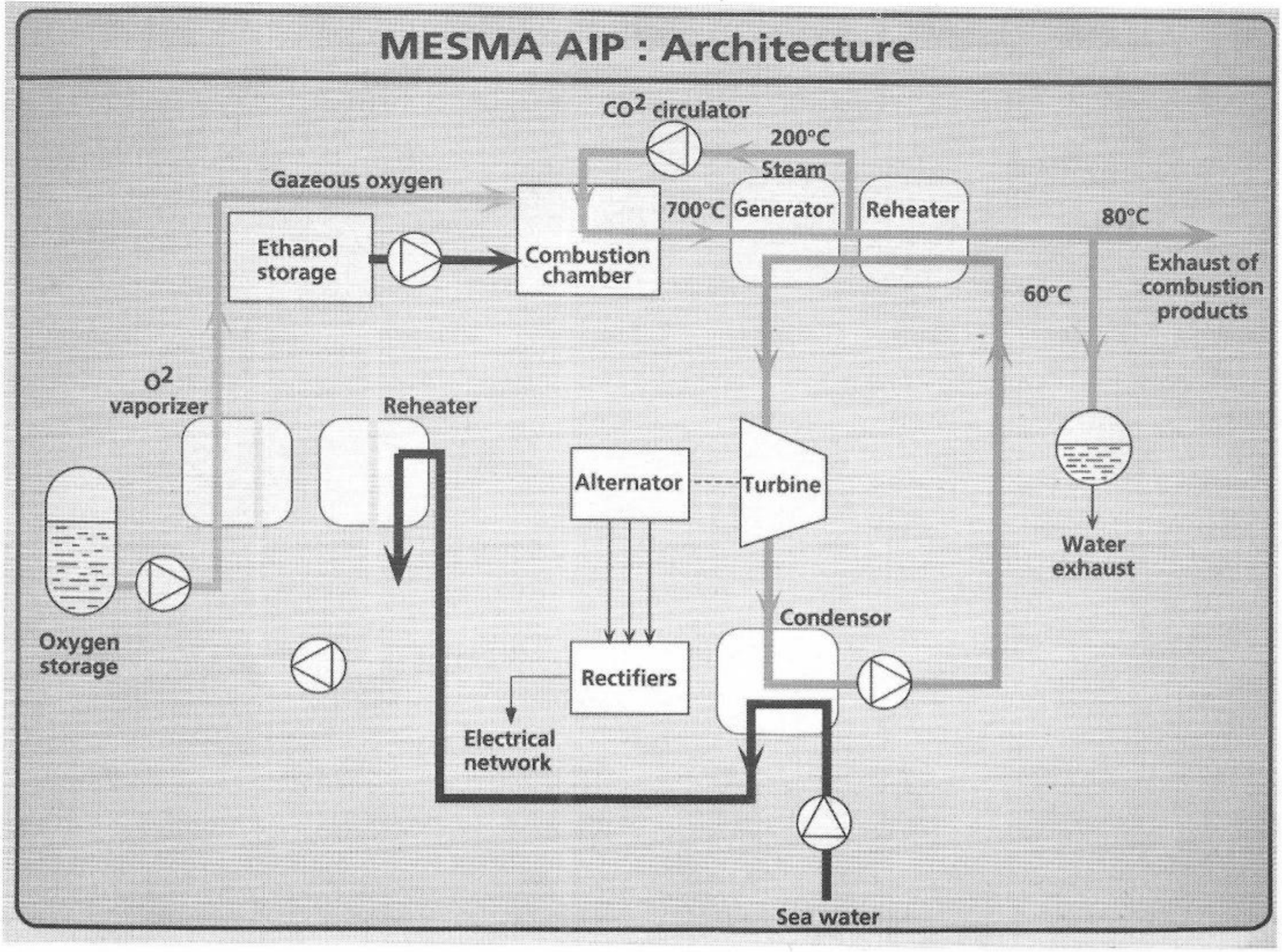
Siemens KWU, Erlangen, Germany.

THE FRENCH THERMAL ENERGY SYSTEM

Module Energie Sous-Marin Autonome (MESMA)

MESMA produces thermal energy from the combustion of a mixture of ethanol and oxygen in the primary circuit, which is subsequently converted to electrical energy through a conventional Rankine cycle. The LOX, stored at −185° is pumped into a vaporiser, similar to that used in nuclear plants, where it becomes gaseous and is then passed to the combustion chamber and combined with ethanol to produce a thermal output of 700°C at a pressure of 60 bar.

The exhaust gases from the combustion process are then passed through a heat exchanger before being expelled from the submarine, except for a proportion, which is recycled into the combustion chamber to regulate the temperature in the primary circuit. The secondary circuit is a conventional steam-driven Rankine cycle turbine driving a high-speed turbo-alternator to supply direct-current electricity to the submarine's machinery and services.



The MESMA AIP system which will be used to power the 'Agosta 90B' class submarines for the Pakistan Navy (DCN International)

The system is claimed to have a number of advantages. First, it uses techniques derived from the nuclear propulsion industry and is produced by companies with long experience in that area. Secondly, because the exhaust gases are ejected at 60 bar, they can be expelled from the submarine at any depth without the use of an auxiliary pump. Thirdly, it uses rotating rather than reciprocating machinery, thus eliminating low-frequency noise.

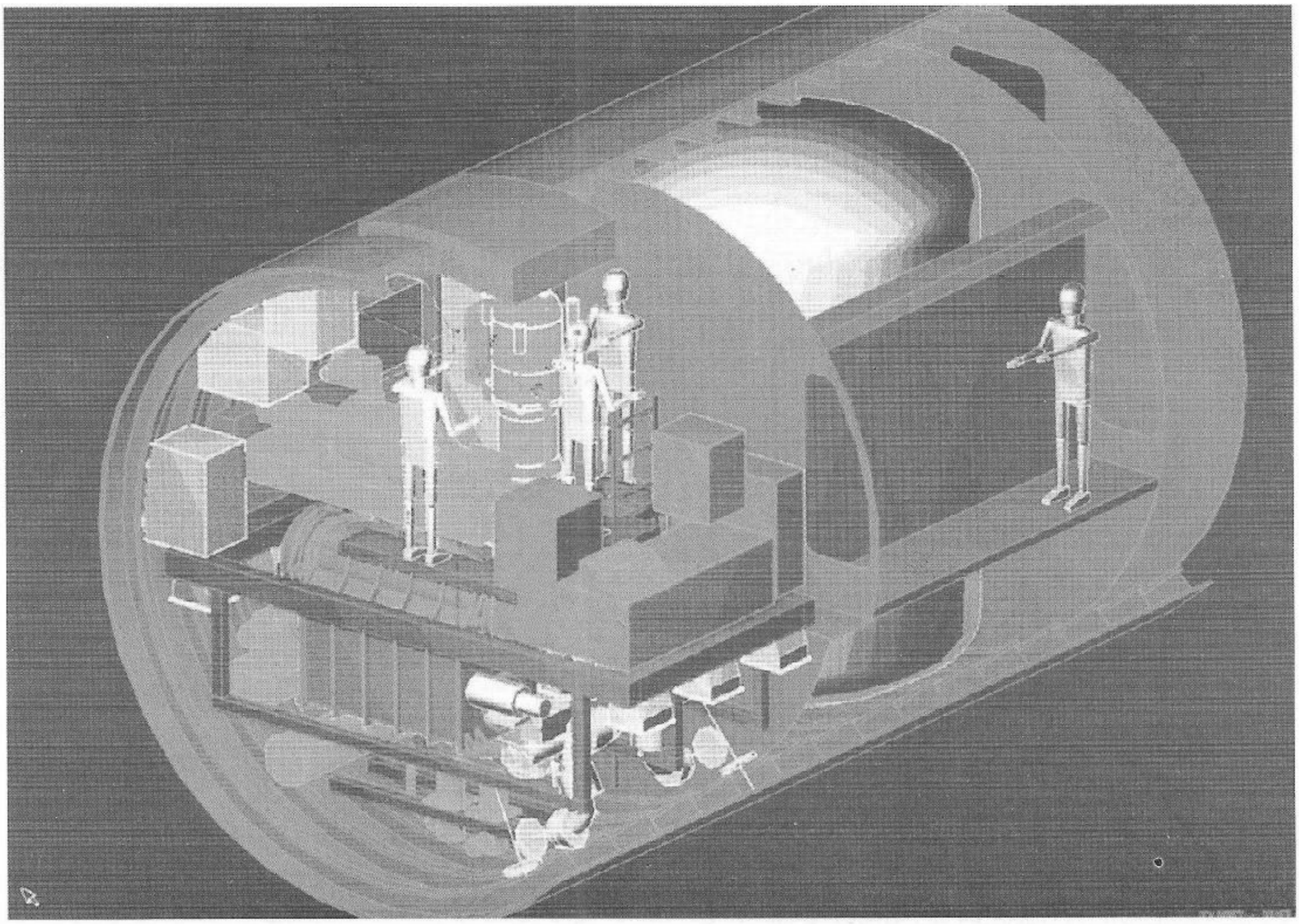
The primary loop system has undergone extensive trials since 1988, using various types of fuel to prove the ignition and regulation systems, and to evaluate endurance. This has led to a full-scale *prototype á terre* (PAT) which started trials at DCN Indret in 1996. The first application of the system will be in the third Agosta 90B ordered by Pakistan, which will also conduct the sea trials of the system. The first two Agosta 90Bs will then have plugs inserted to convert them to the same system. The system is also being offered with the Scorpene submarine design, but, like other AIP systems, can be applied to virtually any diesel-electric submarine.

The self-contained plug displaces 220 t and is 8.67 m (28.44 ft) long. It is claimed to propel the submarine at a maximum of 4 knots and to increase submerged endurance by a factor of 5.

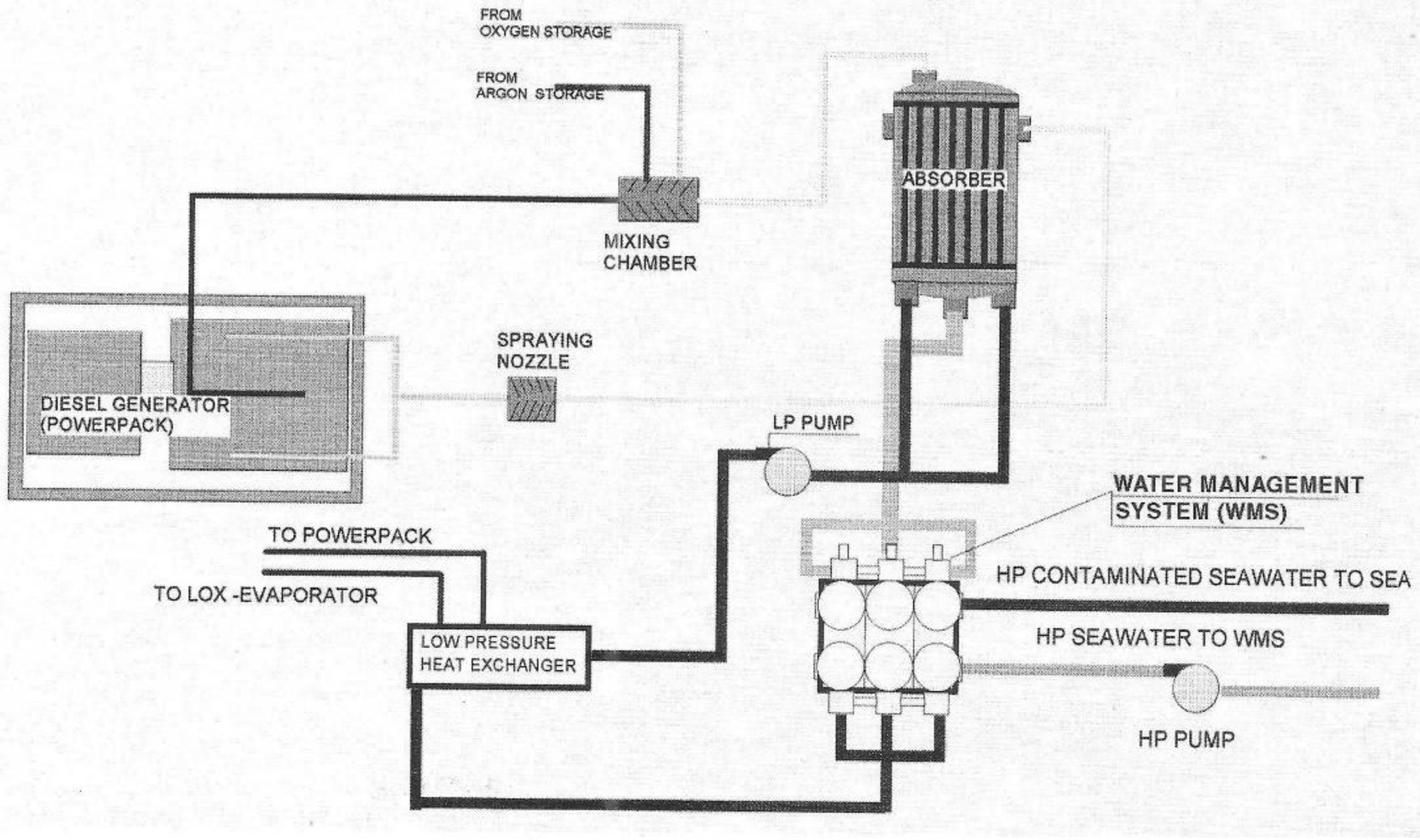
Manufacturers/Contractors

DCN International, Paris, France (prime, secondary loop, system integration).
L'Air Liquide, F-75321 Paris Cedex 07, France (LOX storage, cryogenic pumps).
Bertin, F-78373 Plaisir Cedex, France (combustion chamber, primary loop).
EN Bazan (ethanol storage and integration).

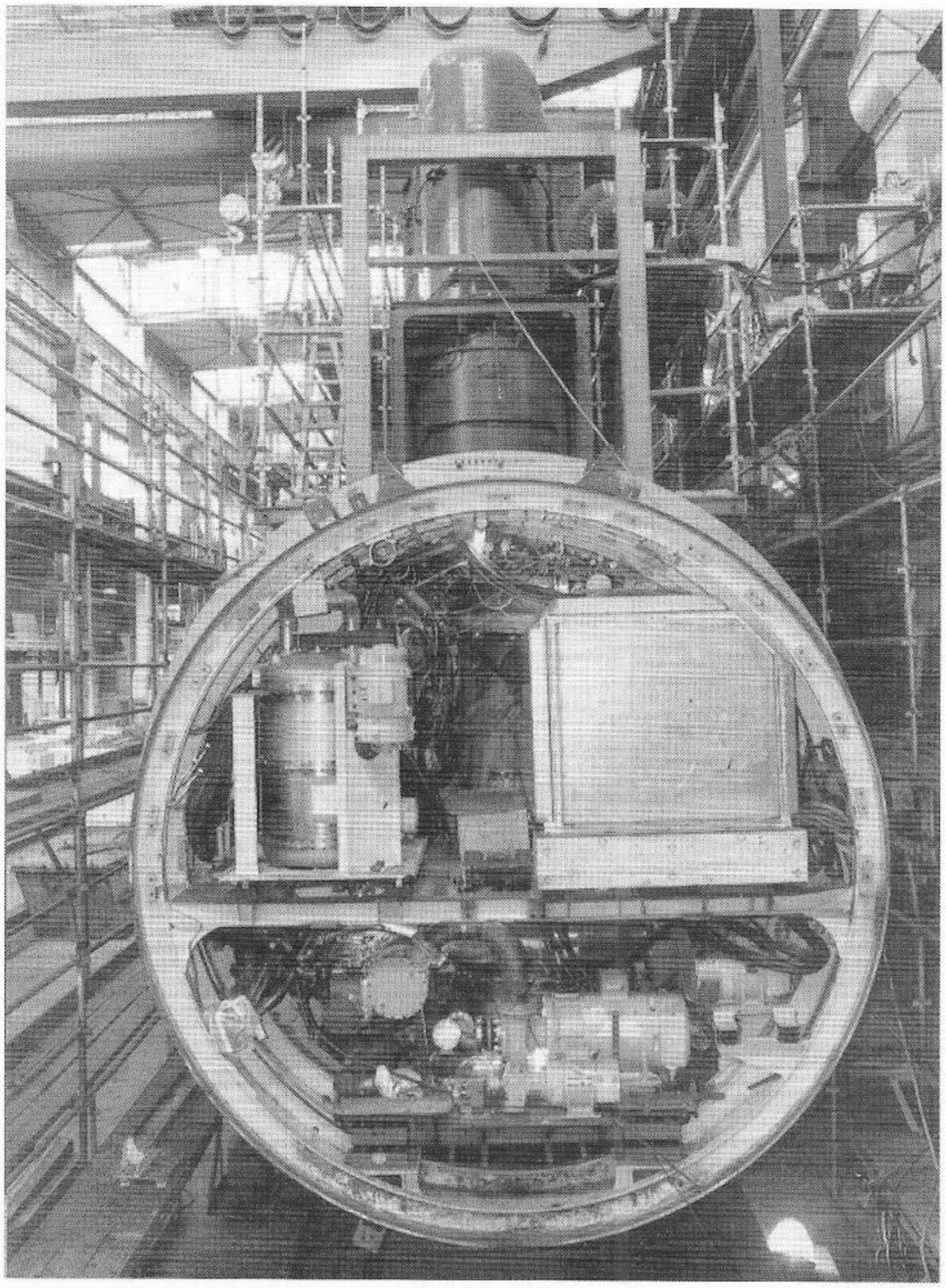
The new Pakistani submarine will appear very similar to Hurmat, lead ship of the first production batch seen here, but the MESMA plug will add another 8.67 m (28.44 ft) in length (DCN International)



The MESMA 'plug' is self-contained and displaces 220 tonnes (DCN International)



Thyssen-Carlton Closed-Cycle Diesel (CCD) system (TNSW)



CLOSED-CYCLE DIESELS — 1

Thyssen-Carlton Closed-Cycle System

The closed-cycle diesel system uses a standard, off-the-shelf diesel engine. The exhaust gases, consisting mostly of carbon dioxide, nitrogen, water vapour and a small amount of unburnt oxygen are cooled to about 80°C and are then fed into an absorber, which is a rotating scrubbing system, in which a rotor mixes the exhaust gas with seawater. The process dilutes the carbon dioxide (CO_2) in seawater and condenses the water vapour, recirculating the inert gases as well as the unburnt oxygen. This gas mixture is enriched with oxygen and brought back to the motor's intake for a new combustion cycle. Due to a higher percentage of CO_2 in the inert gas, the specific heat ratio of the combustion would be lower than with ambient air, so to use an unmodified diesel motor, the specific heat ratio is increased to normal level by adding a small amount of monatomic gas, in this case, argon. The result is a conventional diesel-electric propulsion plant capable of air-independent operation, but which can be switched back to operate in an open-cycle mode whenever it is required to do so.

The working principle for the extraction of CO_2 is based on the different solubility of gases in seawater. In the absorber this extraction takes place at a constant low-pressure level. A rotating drum provides thorough mixing of the exhaust gas with seawater. CO_2 is dissolved due to its high solubility. Nitrogen remains in the cycle due to the balance between the partial pressures of this element in seawater and exhaust gas. Unburnt oxygen and argon are dissolved in very small quantities, due to their low solubility in water. The gas-laden seawater is discharged outboard, where the gases remain dissolved without forming bubbles which could be detected by various anti-submarine detectors.

Since the absorber is working at constant pressure and seawater pressure varies with the submarine's diving depth, the pumping power required to discharge the seawater would be a severe drain on the system's power output and would also be depth dependent. This is overcome by the Water Management System (WMS) which uses the energy of the incoming seawater and decouples the outside and circuit pressures.

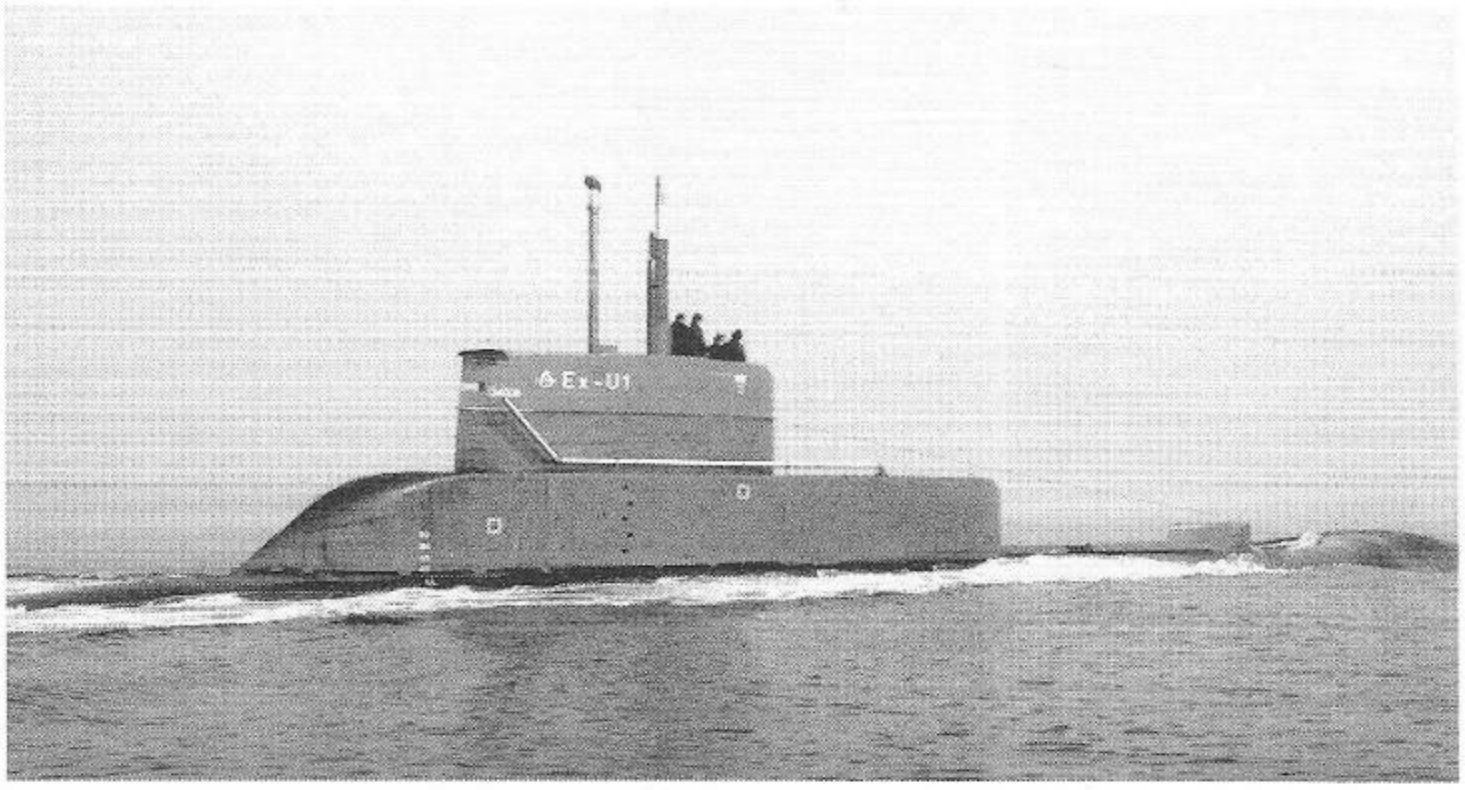
Thyssen Nordsee Werke (TNSW) used submarine 'Ex-U1' to test the CCD system. Here the CCD 'plug' has been mated to the hull with the encased diesel unit in the acoustic housing at the upper right (TNSW)

Liquid oxygen (LOX) is stored aboard cryogenically to obtain a high storage density at a temperature of −180°C in double-skinned, vacuum-insulated tanks.

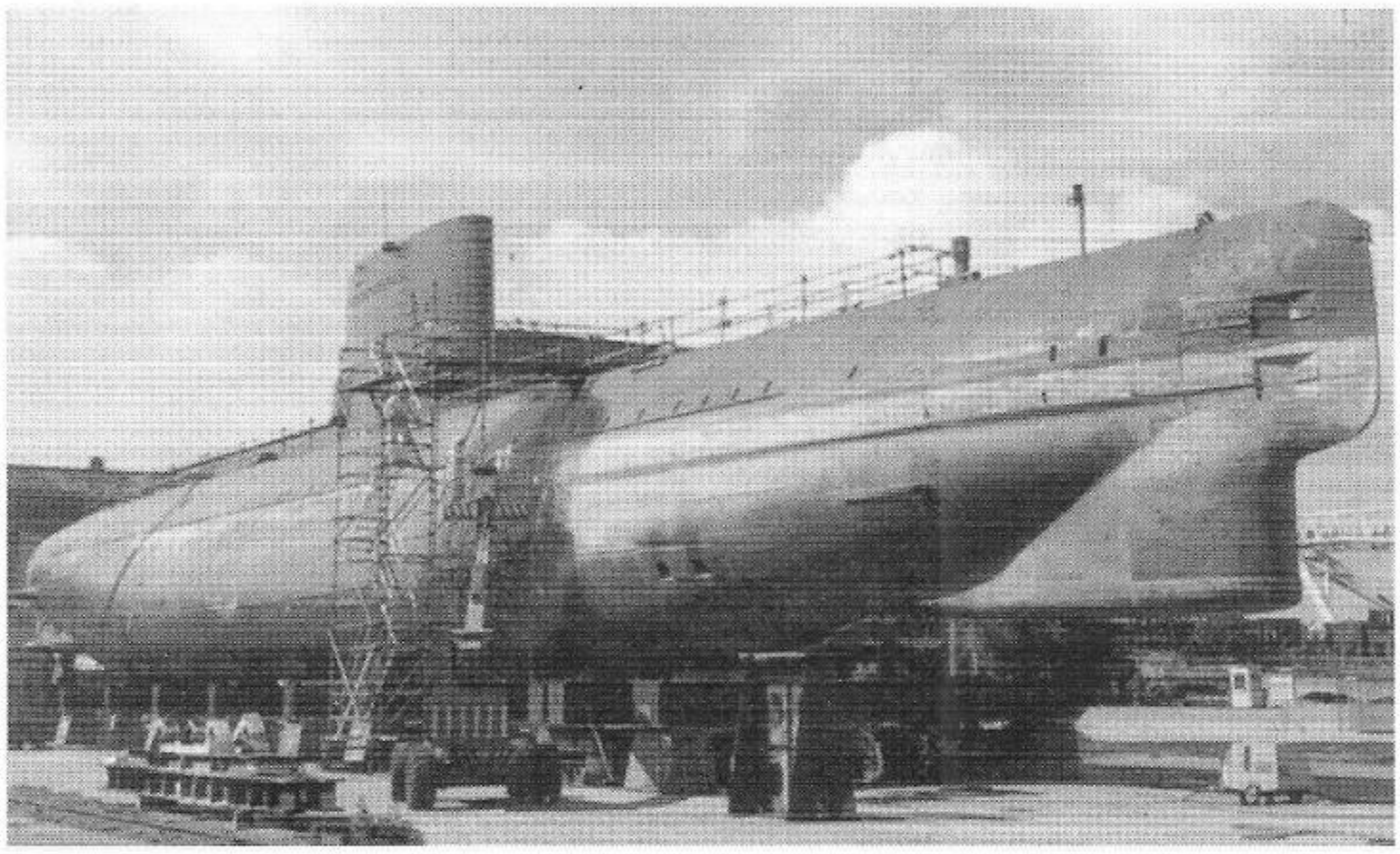
The closed-cycle diesel unit is in a 'plug' which adds about 10 per cent to the original displacement of the submarine. A typical section for a submarine pressure hull with a 6.2 m diameter would be 6.5 m long, containing:

one MTU 8V-183-SE52 280 kW diesel engine
AC generator
water management system
CO_2 absorber
35 tonne LOX in two double-hulled, vacuum-insulated tanks
1.5 tonne gaseous argon in pressure bottles
electric distribution board
auxiliaries, cabling and piping
compensating tanks for LOX and argon consumption

The system is claimed to cause a negligible reduction on the submarine's present performance but to increase the submerged endurance by a factor of five. Maximum depth is 500 m.



Submarine 'Ex-U1' at sea powered by the CCD unit (TNSW)



DTV Zeehord *(DTV = Diving Test Vehicle) is the former Netherlands Navy submarine* Zeehord. *It is now being used by RDM to test the RDM-Carlton CCD system* (RDM)

Manufacturers/Contractors

Thyssen Nordseewerke, Emden, Germany.
Carlton Deep Sea Systems (CDSS), Kettering, Northants, UK.

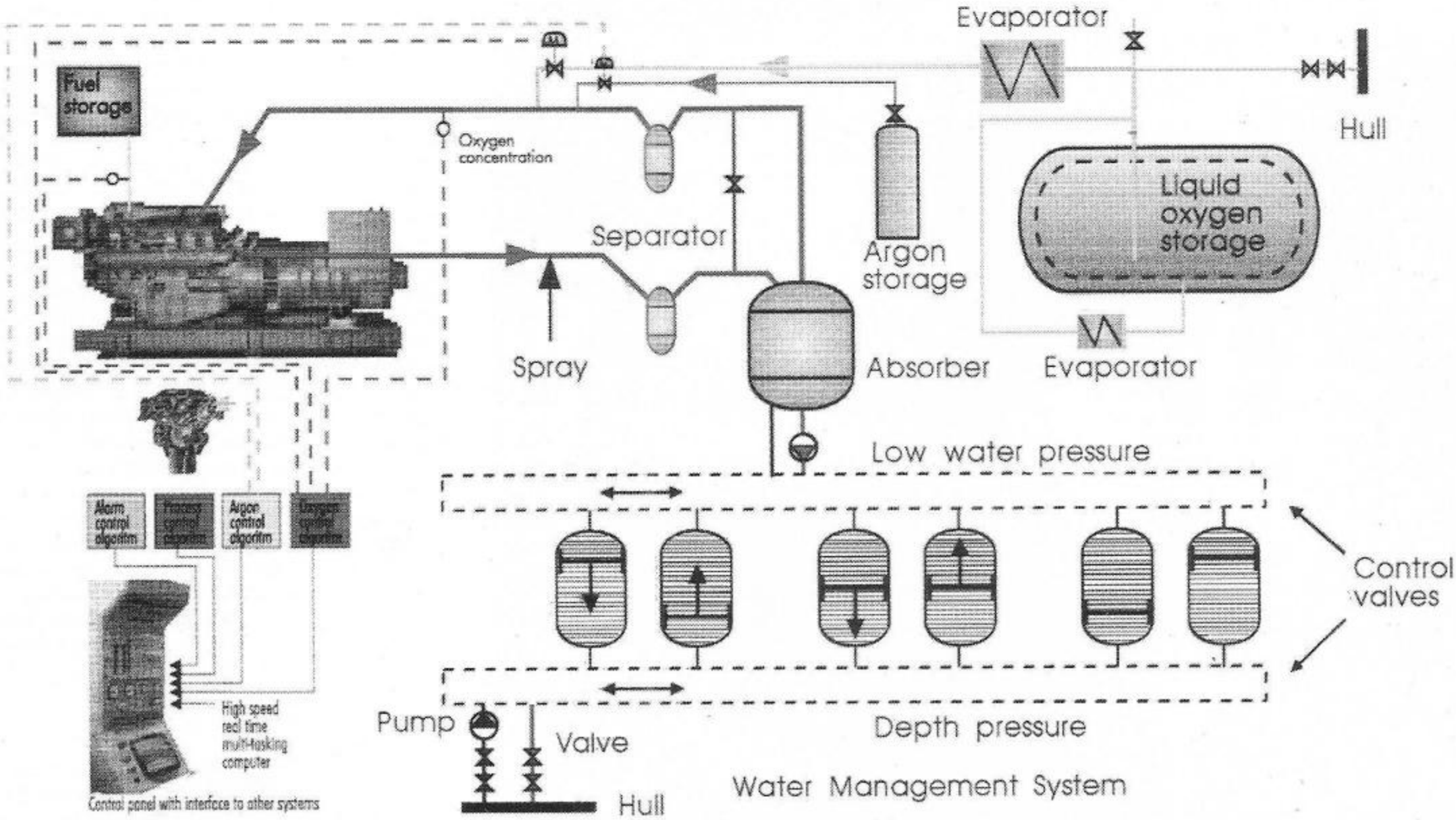
CLOSED-CYCLE DIESELS — 2

The RDM-Carlton closed-cycle diesel

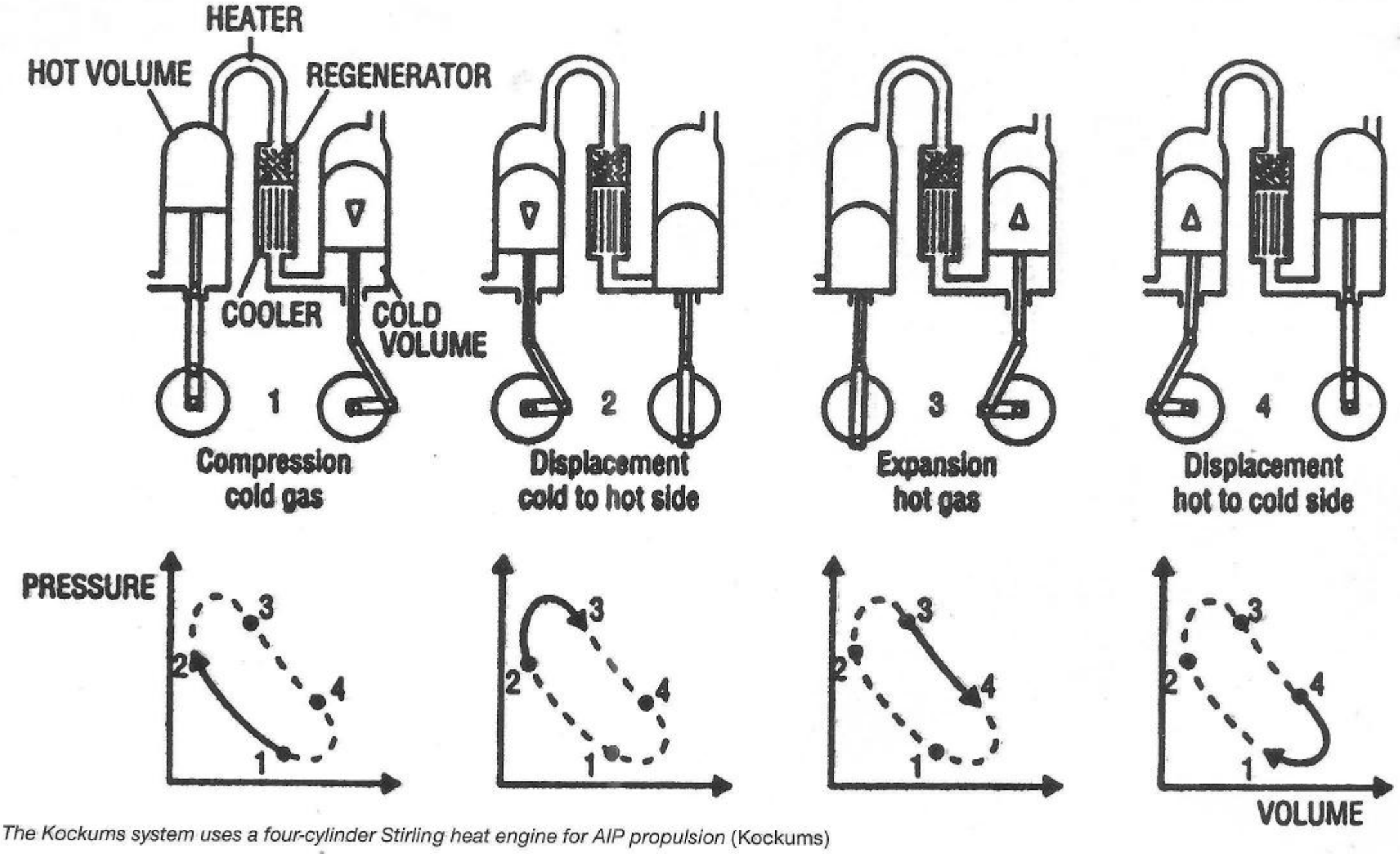
Dutch submarine constructor RDM has developed a closed-cycle diesel AIP system, which, like the TNSW system, is based on patents held by Carlton Deep Sea Systems. The system is known as SPECTRE (Submarine Power for Extended Contact Trailing and Range Enhancement). RDM has been operating a land-based test facility since 1987, based on a Mercedes diesel engine. Originally there were two CDSS rotating carbon dioxide scrubbers working in parallel but Stage II involved a single Mk III absorber, a three-phase water management system and a single-person control system. Stage III — the SPECTRE system — involves an MAN 12-cylinder diesel in a system providing 400 kW usable power and is being offered as an option in the 1,800 tonne version of the RDM/VSEL 'Moray' class export submarines.

Manufacturer/Contractor

RDM Submarines bv, 3000 AV Rotterdam, Netherlands.
Carlton Deep Sea Systems (CDSS), Kettering, Northants, UK.



The Spectre closed-cycle diesel system (RDM)



The Kockums system uses a four-cylinder Stirling heat engine for AIP propulsion (Kockums)

THE STERLING AIR-INDEPENDENT PROPULSION SYSTEM

The Sterling principle is used to convert heat into mechanical work through a thermodynamic process, burning pure oxygen and diesel fuel in a pressurised combustion chamber. The Kockums V4-275R Mk 2 engine installed in *Gotland* has four cylinders, each with a swept volume of 275 cc per stroke, in a V-layout and connected to a single crankshaft. The engine operates at a constant 2,000 rpm and is mounted on a double-elastic mounting within an acoustic shroud.

The Kockums Stirling engine uses standard diesel fuel from the submarine's normal fuel tanks and liquid oxygen (LOX), which is stored in cryogenic tanks in the lower level of the AIP section (that is, within the pressure hull). These are combined in a ratio of 4 parts diesel fuel to 1 part LOX and are burnt inside a circular combustion unit, with the resultant heat being passed through a heat exchanger to the working gas (helium) which expands over each piston when heated and contracts below each piston when cooled, thus driving the piston up and down, and rotating the crankshaft.

The engine module incorporates a cooling unit, which reduces the temperature of the exhaust gas from about 800°C to about 25°C. The gas then passes through an absorber, which mixes it with seawater, cooling it even further and it is then expelled, without bubbling, into the surrounding seawater. The internal pressure must obviously be higher than that of the surrounding seawater, for such expulsion to take place

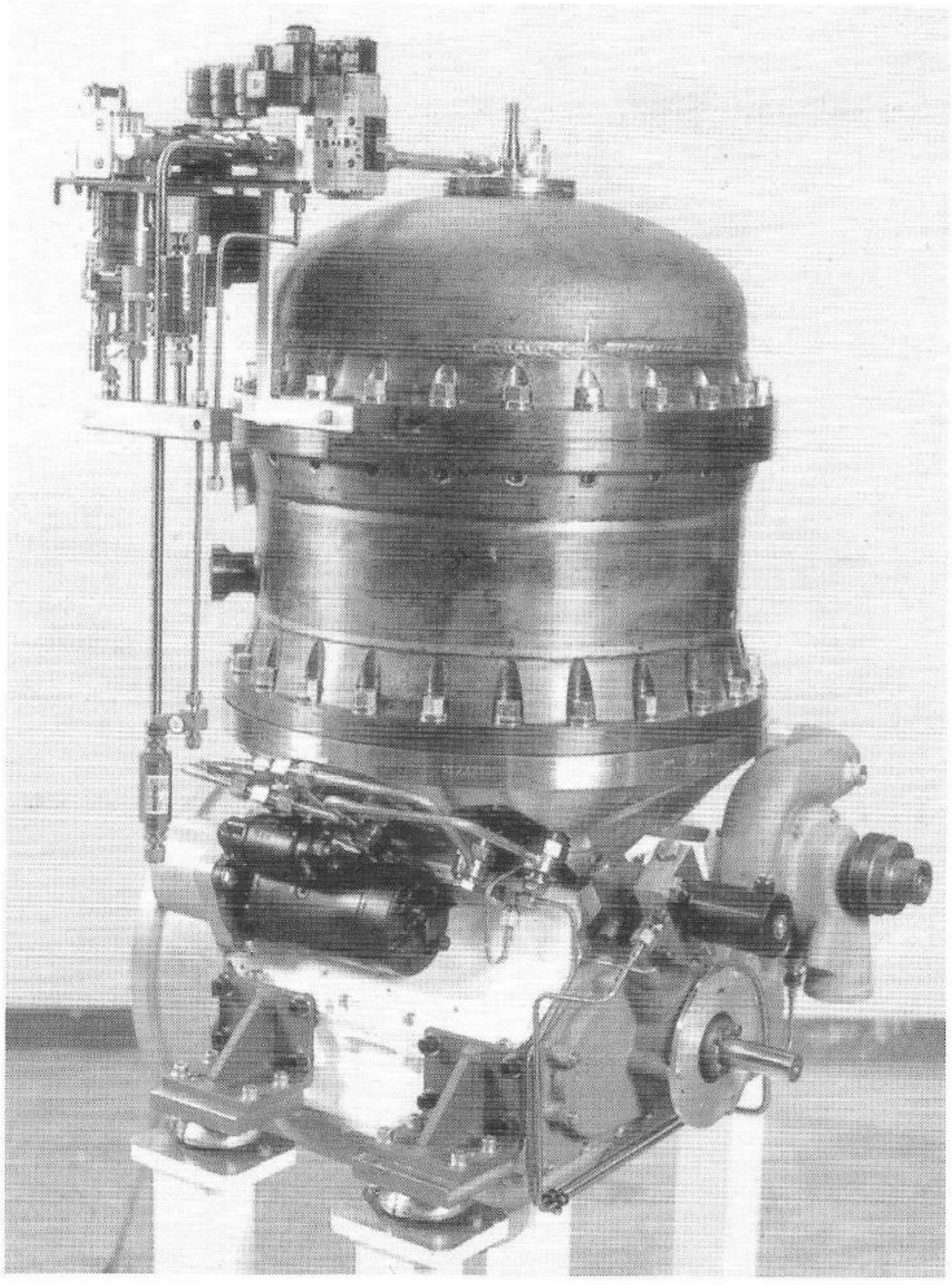
A typical figure for 'hotel load' is some 75-85 kW, which means that in a twin Stirling installation, for example, with each engine producing a rated 75 kW, some 65-75 kW remains to propel the submarine, which is sufficient to maintain a patrol speed of 3 to 5 knots. The only realistic method of increasing this is by installing further Stirling engines, and the *Gotland* was, in fact, originally intended to have three engines, but this was reduced to two on grounds of cost.

Endurance is mainly a factor of the amount of LOX carried, but it is claimed that a Stirling-powered submarine can remain on patrol for five to seven times longer than with batteries.

The Sterling engine is undergoing further development in Sweden. Meanwhile one Mk 1 engine has been on trial in Australia for several years and Japanese engine manufacturer Kawasaki has purchased two Mk 2 engines.

Manufacturer/Contractor

Kockums Submarine Systems, S-205 55 Malmö, Sweden.



The Kockums Stirling engine (Kockums)

OTHER COUNTRIES

A number of other countries is also involved in AIP developments.

Australia, Canada and Japan are known to be examining a variety of systems: both Australia and Japan, for example, have bought Stirling engines from Kockums and are conducting test programmes. Canada is currently conducting a fuel-cell technology demonstrator programme, but this would only become submarine-oriented if a firm order for new submarines is placed.

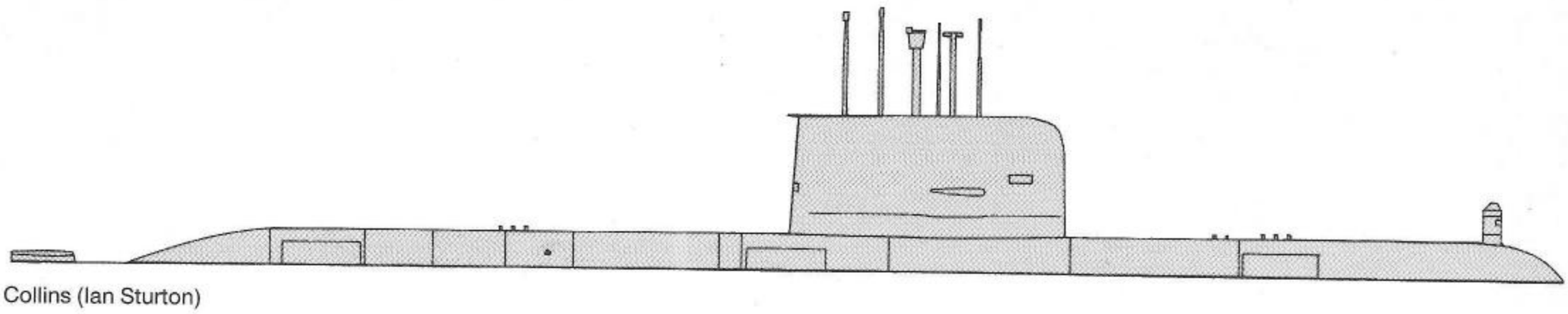
In the UK VSEL was developing an AIP installation for use in the British Navy's 'Upholder' class submarines, but this appears to have been put on a lower priority since the unexpected removal of these submarines from the fleet and placing them on the sales list. There is also some work in the UK on the LAIS cell, which is aimed at producing cells with greater efficiency and longer life than lead-acid cells.

The Fluid Systems Division of AlliedSignal in the USA is also working on a system which uses the Closed Brayton Cycle. No prototype has yet been built, but the great majority of the technology involved is taken from existing systems, such as open-cycle gas turbines.

The Krylov Research Institute in Russia has also carried out a number of test programmes which have included Stirling engines and fuel cells. There are also reports that at least one trials submarine has been constructed.

Swedish submarine Näcken *following the insertion of a 'plug' containing the Stirling engine (Kockums)*

COLLINS



Collins (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Australia

Class: COLLINS

Building: 5
In service: 1

Displacement:
surfaced: 3,050 t
submerged: 3,350 t

Dimensions
Length: 77.8 m (255.25 ft)
Beam: 7.8 m (25.6 ft)
Draught: 6.8 m (22.31 ft)

Speed:
surfaced: 10+ kts
snorting: 10+ kts
submerged: 20+ kts

Range:
surfaced: 11,500 n miles at 10 kts
snorting: 9,000 n miles at 10 kts
Patrol duration: 70 days
Diving depth: 185+ m (600+ ft)

Complement: 42 (7 officers) plus 5 trainees

SUBMARINES

COLLINS (SSG 73)
Builder Australian Submarine Corp, Adelaide, Australia
Laid down 14 Feb 1990
Launched 28 Aug 1993
Commissioned Nov 1995

FARNCOMB (SSG 74)
Builder Australian Submarine Corp, Adelaide, Australia
Laid down 1 Mar 1991
Launched Dec 1995
Commissioned Mar 1997

WALLER (SSG 75)
Builder Australian Submarine Corp, Adelaide, Australia
Laid down 19 Mar 1992
Launched Oct 1996
Commissioned Dec 1997

DECHAINEUX (SSG 76)
Builder Australian Submarine Corp, Adelaide, Australia
Laid down 4 Mar 1993
Launched Sep 1997
Commissioned Sep 1998

SHEEAN (SSG 77)
Builder Australian Submarine Corp, Adelaide, Australia
Laid down 17 Feb 1994
Launched May 1998
Commissioned Nov 1998

RANKIN (SSG 78)
Builder Australian Submarine Corp, Adelaide, Australia
Laid down Mar 1995
Launched Jan 1999
Commissioned Oct 1999

WEAPONS SYSTEMS

ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Sub-Harpoon

Sub-Harpoon has been selected as the main element of the 'Collins' class weapons system. Block 1C includes a number of options, including the ability to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses, or to approach the target indirectly, using up to three preselected waypoints. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 kg)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

Six Strachan & Henshaw 533 mm (21 in) bow torpedo tubes.
Total weapons load, 22.

TORPEDOES

Mk 48 Mod 4

The Mk 48 torpedo is an anti-submarine and anti-ship weapon, capable of operating in wire-guided, acoustic and non-acoustic modes, with the acoustic modes being either active or passive. The wire link is two-way, enabling data from the weapon's homing and guidance system to be relayed to the submarine fire-control system, so that the weapon can be guided more accurately from the submarine.

Specifications
Length: 5.84 m (19.16 ft)
Diameter: 533 mm (21 in)
Weight: 633 kg (1,395 lb)
Range: 21 n miles (38 km) at 55 kts or 27 n miles (50 km) at 40 kts
Max depth: 760 m (2,490 ft)
Max speed: 55 kts
Warhead: 267 kg (589 lb)

Manufacturers/Contractors
Hughes Aircraft Company, Ground Systems Group (prime).
Westinghouse Electric Corporation (second source).

MINES

Mines can be carried in lieu of torpedoes and launched from the tubes. A plan to use the Australian-developed 'Bunny' strap-on mine girdle has, however, been cancelled.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Full details of the ESM suite have not been published, but it is known to be designed to provide threat warning and passive targeting capabilities, even in a high-density signal environment. It provides analysis, classification and accurate bearings, and consists of equipment from ARGOSystems (see right) and Watkins-Johnson.

ARGOSystems AR 740

The AR 740 is an ESM/DF set for submarines, providing threat warning and DF capabilities over the frequency band 2-18 GHz. The system has a nominal sensitivity of -40 dBm and features include automatic signal/data processing, and monopulse direction-finding.

Manufacturer/Contractor
ARGOSystems, Sunnyvale, California, USA.

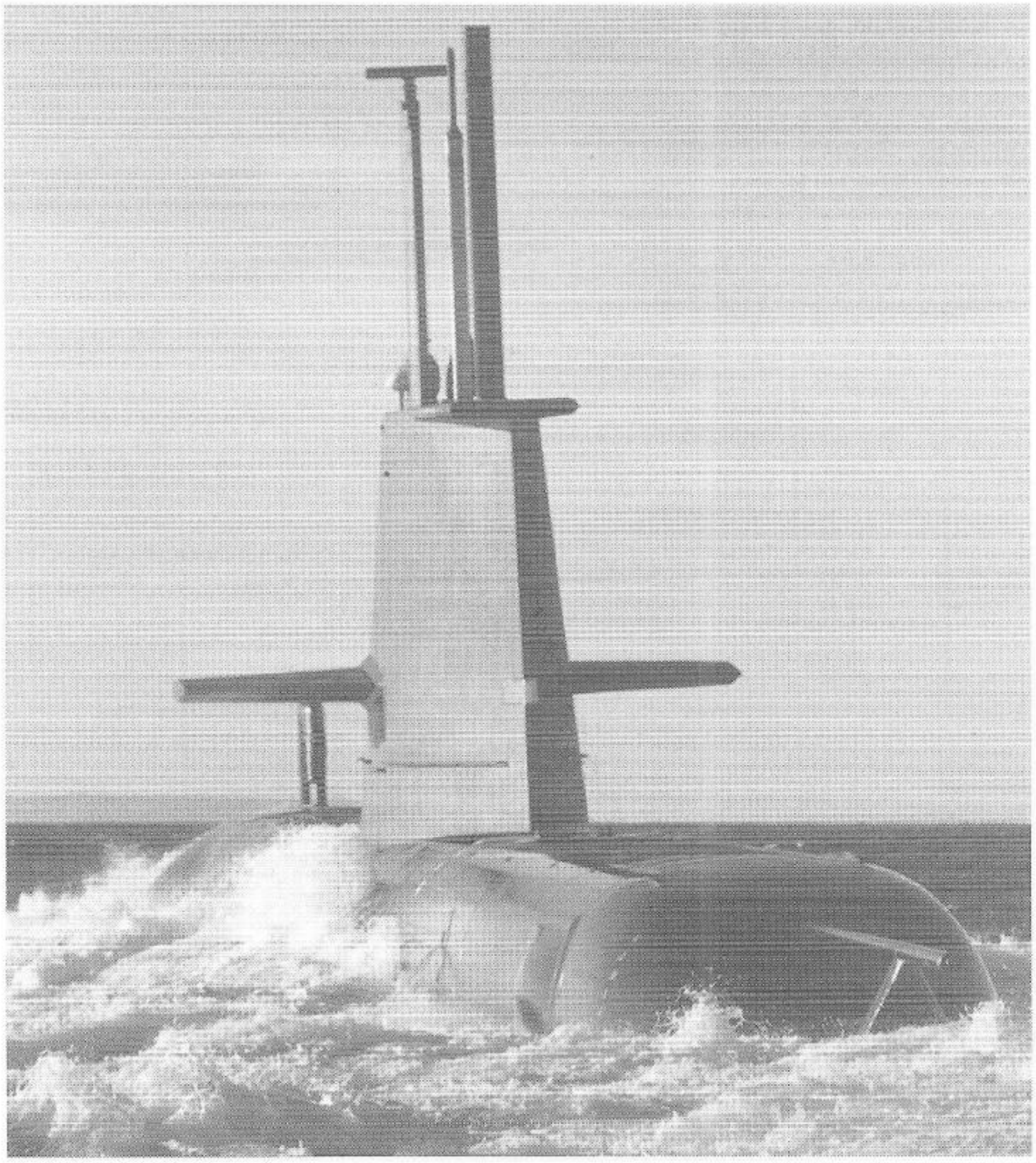
ELECTRONIC COUNTERMEASURES (ECM)

Strachan & Henshaw SSDE

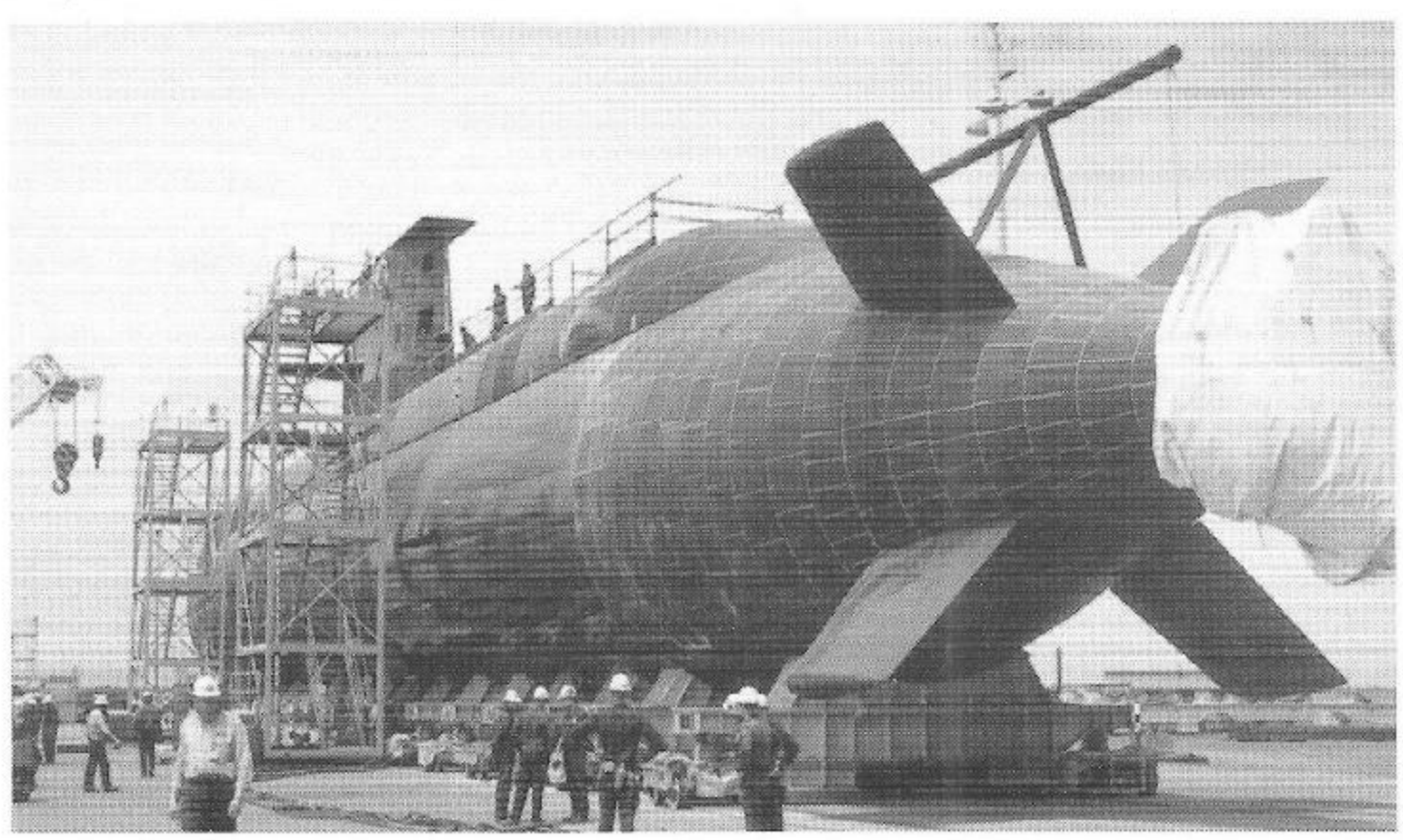
Two Submarine Signal and Decoy Ejectors (SSDE) are installed, one forward, the other aft. These are used to eject decoys, communications buoys and expendable bathythermographs (XBTs).

Manufacturer/Contractor
Strachan & Henshaw, Bristol, UK.

COMMAND AND CONTROL SYSTEMS



Collins *at sea. Sensors atop the sail are (from forward): ESM; Kelvin Hughes Type 1007 surveillance/navigation radar; attack periscope; unidentified* (RAN)



Farncomb *(SSG 74) prior to launch. Note the anechoic tiles, indexed after control surface and the tube used to deploy the Karriwarra thin-line towed array* (RAN)

RADARS

Kelvin Hughes Type 1007

The radar subsystem is provided by GEC-Marconi, with the Kelvin Hughes Type 1007, mounted on its own mast, providing the major input to the internal workstations and the navigation plot.

Specifications
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 31 dB
Pulsewidth: 0.08/0.35/0.8 µs
Pulse repetition frequency: 1,600/800/400 pps
Scan rate: 26 rpm

Manufacturer/Contractor
Kelvin Hughes, Ilford, Essex, UK.

SONARS

Thomson Sintra Scylla

Scylla is an integrated sonar system, derived from Thomson-CSF's Eledone (TSM 2233). There are seven sets of arrays: a large, cylindrical, bow-mounted passive array; two mine avoidance arrays, one active, the other passive, also in the bows; two passive flank arrays (TSM 2253 — see below); an intercept array in a 'beehive' dome on the bow casing and a ranging system composed of six arrays are mounted on the casing sides (TSM 2225 — see below). There is also an active array mounted in the forward edge of the sail and finally a towed array, with the winch in the after casing and a prominent tube leading the array clear of the propeller. The first two submarines have the GEC-Marconi Karriwarra towed array, but it has not yet been decided whether the Karriwarra or the Thomson-CSF Narama will be fitted in the remaining four.

Manufacturer/Contractor
Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, France.

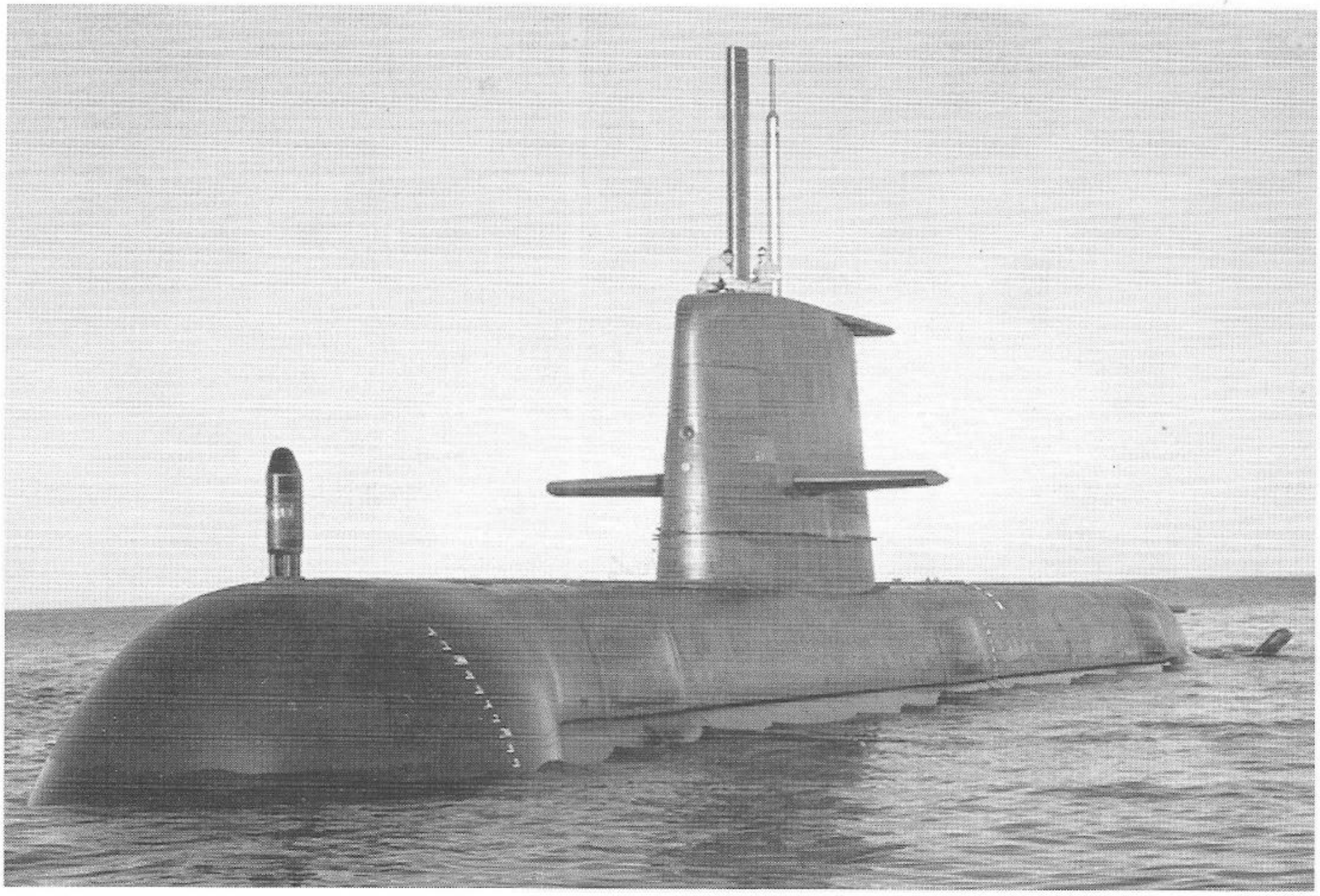
Thomson Sintra TSM 2253

TSM 2253 is the low-frequency passive sonar using two planar arrays installed on the flanks of the Collins class. Each array consists of up to 64 planar hydrophones (0.5 m wide, 1 m in height, 0.1 m thick) composed of polyvinyldifluoride (PVDF) films moulded in polyurethane. Compared to linear configured ceramic hydrophones the planar array has a high resistance to shock, offers directivity in elevation, achieves noise cancellation due to the surface effect and imposes very few installation constraints. The sonar performs panoramic surveillance through simultaneous processing of broadband and narrowband and automatically initiates tracking on up to 64 targets. In addition the operator can initiate up to 8 tracks. Signal analysis is carried out using Lofar, Demon and audio with computer-aided classification. Localisation is through specific TMA.

Manufacturer/Contractor
Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, Paris, France.

Thomson-CSF TSM 2225

TSM 2225 is the latest version of DUUX-5 and consists of a set of six arrays, three on each side of the casing, constructed from polyvinyl difluoride (PVDF)



Collins *at sea. The intercept sonar is in the 'beehive' on the forward casing and the three rectangular TSM 2225 can be seen along the side (RAN)*

bidimensional transducer material. There is also an internal cabinet and console. The sonar performs panoramic surveillance and pulse interception, target and automatic pulse tracking and ranging, and target localisation. Simultaneous tracking of up to four noise generators and two sonar emitters is carried out using Lofar, Demon and pulse-more analysis. Software is written in C and Ada.

Manufacturer/Contractor
Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, France.

GEC-Marconi Karriwarra

Karriwarra is a thin-line towed array, based on original work carried out by the Australian Defence Science and Technology Organisation (DSTO) and is a digital version of the analogue system, known as the Self-Streaming Towed Array Sonar (SETAS), which has been in continuous service with the 'Oberon' class submarines of the Royal Australian Navy for seven years.

Karriwarra streamers are exceptionally robust and durable, with acoustic performance better than equivalent oil-filled streamers. The Karriwarra construction utilises a combination of tough buoyancy-controlled polymers and is modularised into functional sections joined by titanium electromechanical connectors and is easily repairable.

Manufacturer/Contractor
GEC-Marconi Systems, Meadowbank, New South Wales, Australia.

WEAPONS CONTROL

Team Rockwell integrated combat system

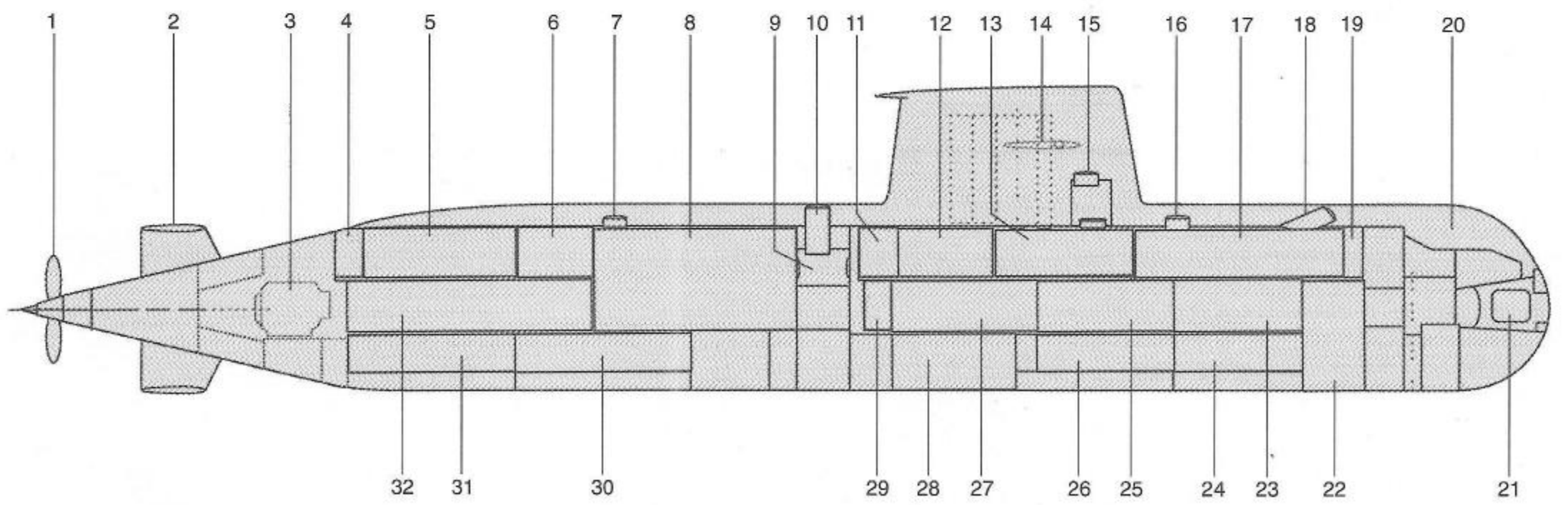
The combat system architecture is based on distributed processing within a number of functional elements, which are interconnected and integrated by a high-capacity serial databus. Key elements are the MultiFunction Common Consoles (MFCCs) and the Command Plot (CP), with large processing capacity embedded in each of them. All programming is done in Ada. Sensor inputs are integrated at the data level enabling any operator to display and correlate data from up to eight independent sensors simultaneously.

Manufacturer/Contractor
Rockwell International, Duluth, Georgia, USA.

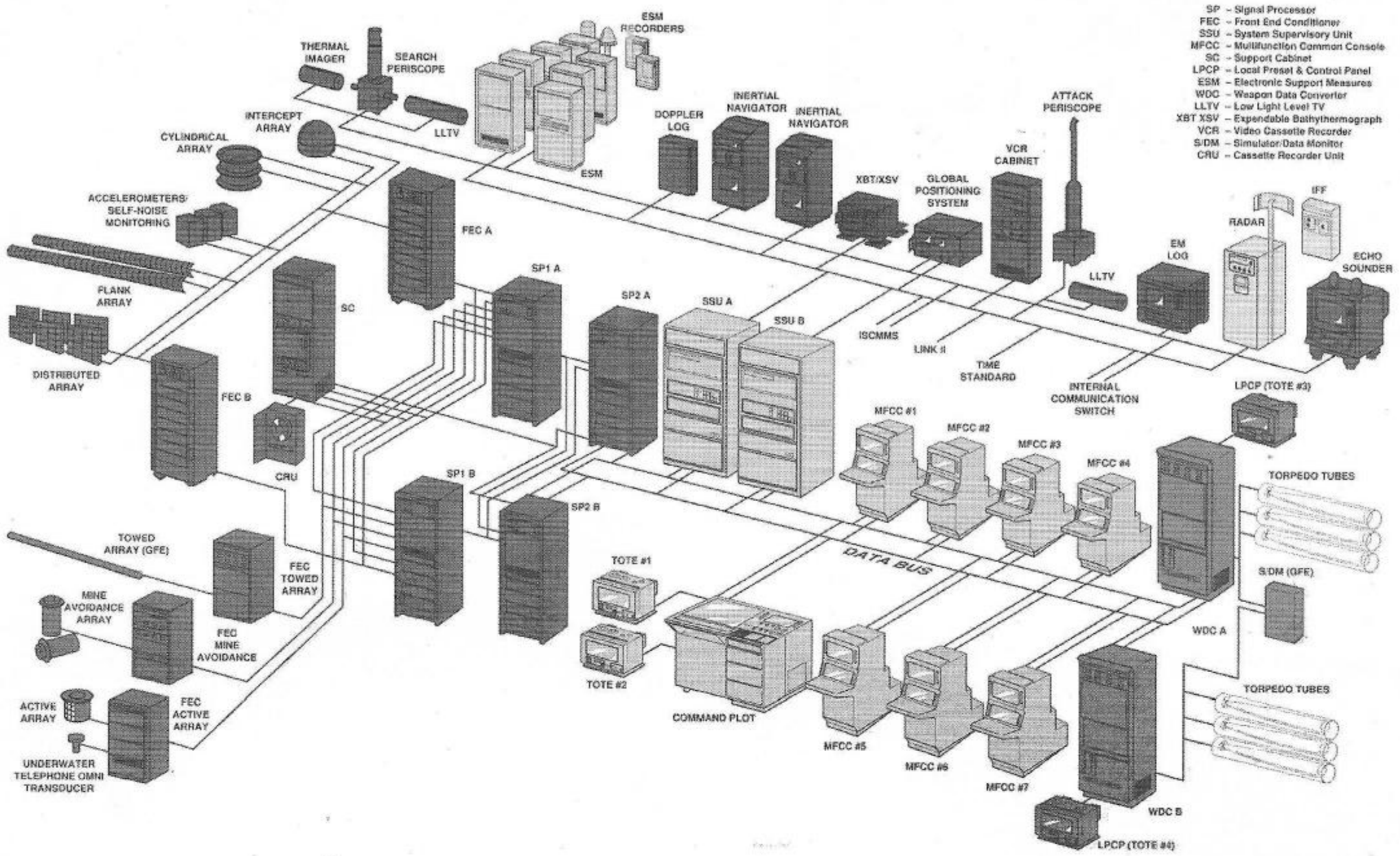
PERISCOPES

Pilkington Optronics CK 43 search.
Pilkington Optronics CH 93 attack periscopes.

Manufacturer/Contractor
Pilkington Optronics, St Asaph, Clywd, UK.



'Collins' class — internal layout (RAN)
1 *Seven-bladed skew-back propeller* **2** *Swept-back, indexed, after hydroplanes* **3** *Motor room* **4** *Engineers' workshop* **5** *Electrical equipment space* **6** *Motor control room* **7** *Battery hatch* **8** *Main generator room* **9** *Tunnel* **10** *Escape tower* **11** *Ship's office* **12** *Communications centre* **13** *Control room* **14** *Forward hydroplanes* **15** *Conning tower* **16** *Accommodatation hatch* **17** *Upper accommodation space* **18** *Weapons hatch* **19** *Torpedo equipment space* **20** *Bow sonar area* **21** *Torpedo tube front cover* **22** *Tube space* **23** *Weapon stowage compartment* **24** *Battery compartment #1* **25** *Domestic services space* **26** *Battery compartment #2* **27** *Lower accommodation space* **28** *Auxiliary machinery space #1* **29** *Lower electrical space* **30** *Battery compartment #3* **31** *Battery compartment #4* **32** *Auxiliary machinery space #2*



The Team Rockwell combat system for the 'Collins' class (RAN)

DATALINK

NATO Link 11 equipment is installed, but is believed to be receive only.

NAVIGATION

Two Litton Ships Inertial Navigation Systems (SINS)
Collins Global Position System (GPS)
Electromagnetic log
Doppler velocity log
Honeywell ELAC echo-sounder.

DEGAUSSING

GEC-Marconi SDG-1800

The SDG-1800 provides a magnetometer and geomagnetic world map-based control system with a range of degaussing coil-drive power amplifiers. The unit interfaces with the submarine's databus to facilitate world map-based control.

Manufacturer/Contractor

GEC-Marconi Radar and Control Systems, Leicester, UK.

PROPULSION

Specifications

System: Diesel-electric
Diesel engines: 3 Hedemora/Garden Island Type VB 210, 18-cylinder diesels; 5.4 MW (7,344 hp(m))
Electric motor: 1 water-cooled, DC-shunt, double-armature, Jeumont Schneider motor; rated power 5.25 MW
Generators: 3 Jeumont Schneider; each 1.4 MW at 440 V DC
Shafts: 1
Propeller: 1—7-bladed, skew-back propeller
Emergency propulsion: 1 MacTaggart Scott DM 43006 hydraulic motor
Battery: 4 batteries, Varta cells

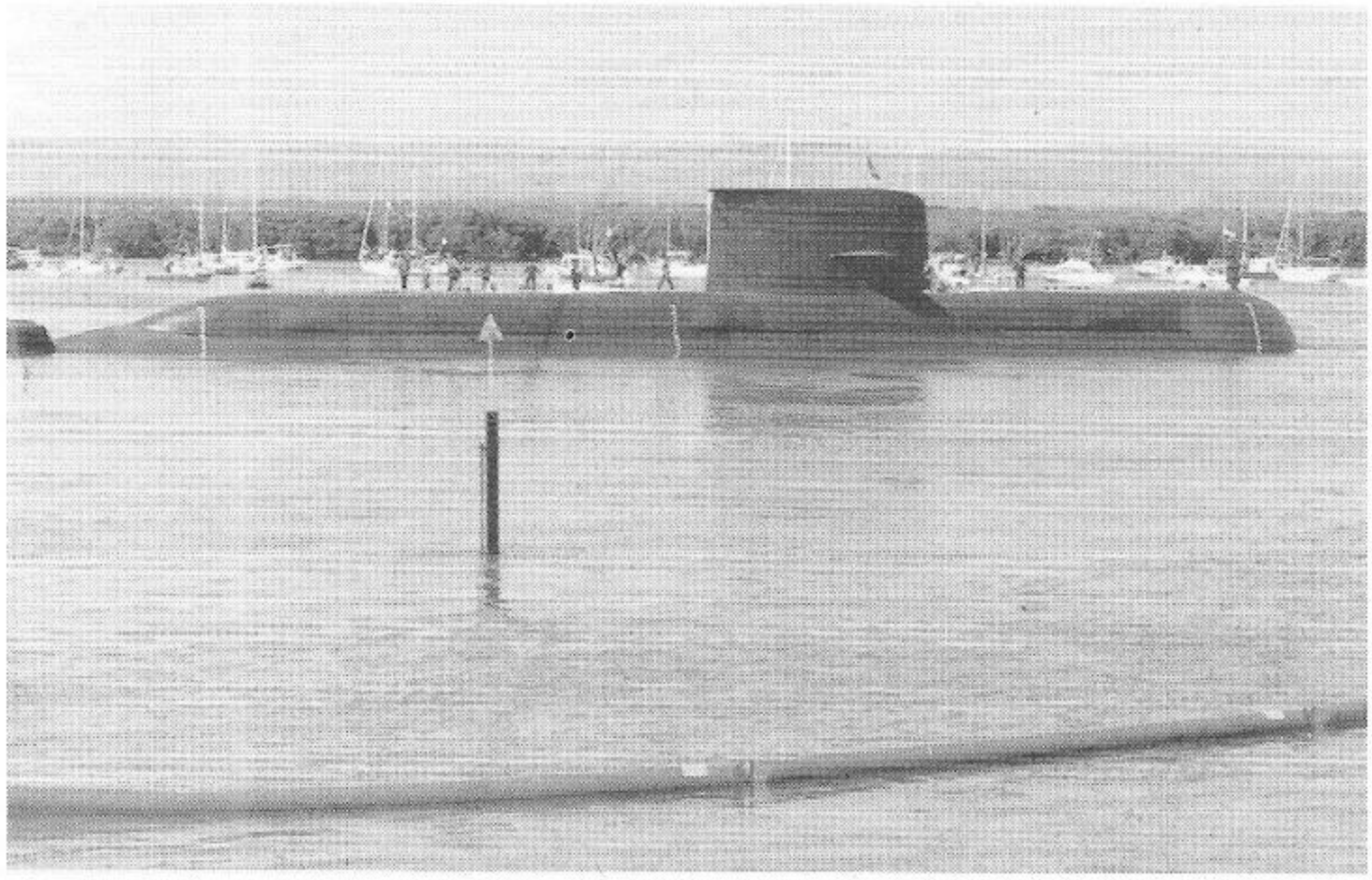
FURTHER INFORMATION

PROGRAMME

In the 1980s the Royal Australian Navy (RAN) found itself faced with the approaching obsolescence of its six 'Oxley' class (British-built 'Oberon' class) patrol submarines. It therefore carried out a stringent appraisal of its strategic and tactical needs, before conducting a lengthy survey of the various designs on the market. In addition to the purely naval factors, there was an industrial requirement that the submarines and a substantial part of the equipment should be built in Australia. The Type 471 design by Swedish company Kockums was eventually selected, with the order for six boats being signed on 3 June 1987; an option on a further two has not, however, been taken up.

OPERATIONAL REQUIREMENTS

Australia's requirements are unusual, with a 20,000 km long coastline to patrol and a very large oceanic theatre of action. Thus, the submarine force must be able to undertake both short duration coastal patrols as well as lengthy open-ocean, defensive and offensive operations in the Indian, Pacific and Antarctic Oceans, and



Collins *shows its exceptionally clean lines* (RAN)

the Tasman Sea. This necessitates a fairly large submarine, capable of long-range, autonomous operations.

A significant factor in meeting the requirement was that the RAN had already decided on a functional approach, which divided the submarine's role into three elements: surveillance, track prosecution and support.

Surveillance covers the automatic detection, classification, tracking and management of contact data from both passive and active sensors, including sonar arrays, periscopes, electronic support measures, radar and optronics.

The track prosecution function enables the operator to review and improve the estimate of the overall tactical picture provided by the surveillance function, either by interrogating the background processing or by invoking independent processes. This provides a complete set of planning and decision support aids for the engagement planning and the means to select, preset, launch and guide weapons against a chosen target.

The support function provides for those activities, outside the tactical mainstream, which are still necessary for overall mission effectiveness. Thus, equipment and software are provided for data recording, system performance monitoring and fault location, environmental analysis, system initialisation, navigation and onboard training.

DESIGN

It is frequently assumed that the Collins is a slightly enlarged version of the Swedish Västergötland or Gotland designs. In fact, the Collins is a very much larger submarine, as shown in the table below, with over twice the submerged displacement, 30 per cent greater length and beam, and 100 per cent more crew than the Västergötland, and is essentially a totally new design, which happens to share many of the design features and technology of the Swedish submarines:

Name	Väster -götland	Gotland	Collins
Type No	A-17	A-19	471
Displacement (submerged)	1,143 t	1,490 t	3,298 t
Length	48.50 m	60.0 m	77.42 m
Beam	6.06 m	6.06 m	7.80 m
Crew	20	20	41

The Collins is a single-hull design, of typical Swedish submarine shape, essentially a long, parallel-sided tube, with a virtually hemispherical bow, a single propeller and forward hydroplanes mounted on the sail. The after control surfaces are in an X-form and, whereas other examples of such surfaces are at 90° to the hull, in the Collins' case they are swept back at some 30° although the reason for this has not been made public. The hull is constructed of microalloy steel, specifically developed in Sweden for submarine construction and is covered by anechoic tiles (these were not fitted on Collins, but will be retrofitted once it has completed first-of-class trials).

There are four groups of batteries, provided by German company Varta. The three diesels are Hedemora designs but assembled in Australia by Garden Reach. The electric motor is a Jeumont Schneider design. The propeller is a seven-bladed, skew-back design.

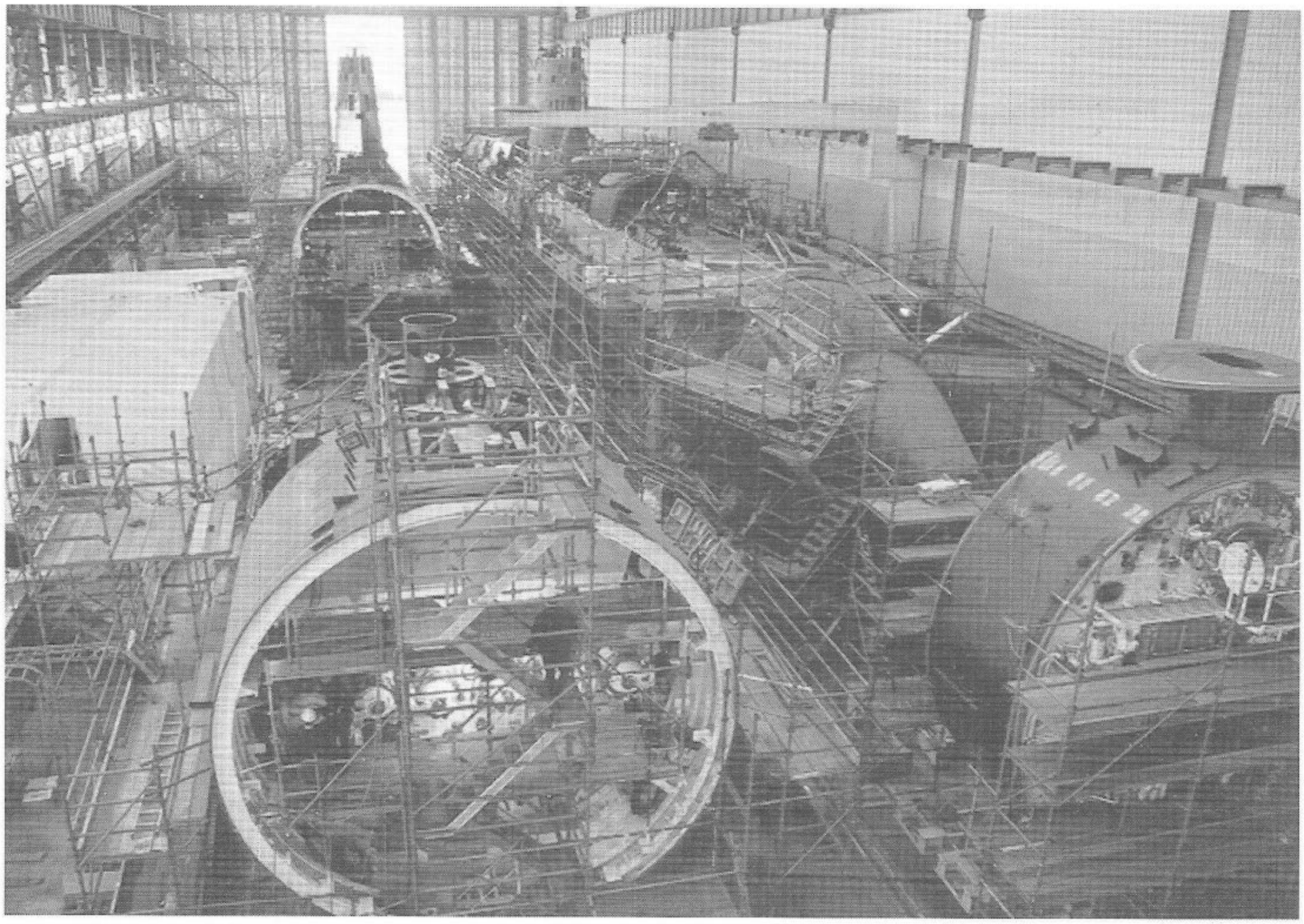
The torpedo tubes are arranged in port and starboard banks, each of three tubes, with each bank being capable of fully independent operation, with all discharge, control and operating equipment being duplicated. The weapon discharge system is produced by British company Strachan & Henshaw to meet the requirements of the Sub-Harpoon missiles and Mk 48 torpedoes which were already in service in the RAN's 'Oxley' class submarines.

MODERNISATION

The RAN retains an interest in the possible use of Air-Independent Propulsion (AIP) and developments are being monitored. The Australian Defence Scientific and Technical Organisation (DSTO) has purchased and is trialling a Kockums Stirling Mk 1 engine. The Collins design makes allowance for the insertion of a plug containing an AIP plant, but acquisition is currently a low priority for the RAN.

DEPLOYMENT

All six boats will be based at Fleet Base West with one or two deploying regularly to the east coast. A 'two crew' cycle was considered and rejected. *Collins* started sea trials on 31 October 1994 and good progress has been made, with the designed diving depth (DDD) being reached for the first time on 19 January 1996.



A crowded scene in the ASC building hall with Farncomb *(SSG 74) on the right and* Walker *(SSG 75) on the left. The construction programme is, however, now past its peak and ASC is seeking export orders to give continuity once the Australian order is completed*

IMPROVED TUPI (SNAC-1)

GENERAL SPECIFICATIONS

Country: Brazil

Class: IMPROVED TUPI
Type: SNAC-1

In service: 0
Proposed: 2

Displacement:
surfaced: 1,850 t
submerged: 2,425 t

Dimensions
Length: 67 m (219.7 ft)
Beam: 8 m (26.2 ft)
Draught: 5.5 m (18 ft)

Speed:
surfaced: 11 kts
snorting: 11 kts
submerged: 22 kts

Range:
surfaced: 11,000 n miles at 8 kts
submerged: 400 n miles at 4 kts
Diving depth: 300 m (985 ft).
Endurance: 60 days.

Complement: 39 (8 officers)

SUBMARINES

TOCANTINS (S 34)

Builder	Arsenal de Marchinha, Rio de Janeiro, Brazil
Laid down	1996
Launched	1998
Commissioned	2000

TAMANDARE (S 35)

Builder	Arsenal de Marchinha, Rio de Janeiro, Brazil
Laid down	1998
Launched	2000
Commissioned	2002

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) bow tubes; swim-out discharge.
Total weapons carried, 16.

TORPEDOES

GEC-Marconi Mk 24 Mod 1 Tigerfish

Tigerfish uses the passive mode whenever possible, with the interrogation rate being progressively increased as the torpedo nears the target to improve system accuracy. The onboard computer performs several functions during the attack, including interrogation control, sonar data computation, torpedo steering control and data transmission to the submarine to update its computer memory. The onboard computer is connected through the guidance wire to the submarine's torpedo fire-control computer. During the wire-guidance phase the torpedo's computer responds to the demands of the submarine computer, with wire being dispensed from both torpedo and submarine to avoid any stress due to their relative motion. Wire guidance ceases at the point where the torpedo's automatic three-dimensional passive/active acoustic homing system can control the final run to the target and during this phase the torpedo computer interprets data from the homing system sensors to calculate and then command the appropriate course, subject to a priority overriding steer-off azimuth control from the submarine.

Specifications
Length: 6.46 m (21.19 ft)
Diameter: 533 mm (21 in)
Weight: 1,550 kg (3,417 lb) (in air)
Propulsion: Electrically driven contrarotating propellers
Performance:
passive: 15.7 n miles (29 km) at 24 kts
active: 7 n miles (13 km) at 35 kts
Max operating depth: 610 m (2,000 ft) (estimated)
Warhead: Royal Ordnance 134 kg (295 lb) PBXN 105 warhead
Fuze: Dual-action impact (inertia-type) and proximity (magnetic)
Power: 2 Chloride silver-zinc oxide batteries driving a 2-speed electric motor
Propellers: 2, contrarotating

Manufacturer/Contractor
GEC-Marconi Underwater Weapons Systems Ltd, Waterlooville, Hampshire, UK.

IPqM torpedoes

Brazilian-designed ASW torpedoes may also be carried. The only known performance parameter is that its effective range is 9.7 n miles (18 km) at 45 kts.

MINES

32 IPqM/Consub MCF-01/100 mines can be carried in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thomson-CSF DR 4000U

DR 4000U is an ESM and radar warning receiver, covering the C- to J-bands, designed specifically for submarine applications. The system offers threat warning, surveillance, emitter identification, ELINT, and automatic EW system control capabilities and can also, if required, be interfaced with decoy dispensers or jammers to control their operation. The DR 4000U antenna array consists of an omnidirectional unit for frequency measurements and two concentric sets of six antennas, one set for the H to J high band for DF and one set for the C to G low band. The DR 4000U provides a very high intercept probability on even short single pulses, and is very sensitive, using crystal video and IFM techniques on both the omnidirectional and DF channels.

Specifications
Frequency coverage: C- to J-band
Bearing accuracy: Approx ±5°

Manufacturer/Contractor
Thomson-CSF, Radars and Countermeasures Division, Elancourt, France.

COMMAND AND CONTROL SYSTEMS

WEAPON CONTROL

Ferranti KAFS action data automation system

KAFS (SSK Action information and Fire-control System) is designed for use by conventional submarines of all sizes, using up-to-date processing techniques and software algorithms to provide a wide range of operational facilities including sensor data handling, target-motion analysis, picture compilation, fire control, tactical calculations and data recording. The control-room console is linked by a MIL-STD-1553B databus to the weapon control equipment in the torpedo room. Full combat information and fire control facilities are provided at each console operator position and either operator can control the whole system thereby allowing one position to be shut down in patrol state. Each console position has two CRT displays, two command data panels, and a weapon control and system status panel. The Brazilian Navy has taken delivery of five systems, four are installed in submarines and one is in a shore training facility. Three were built under subcontract by SFB Informatica in Rio de Janeiro. KAFS can control up to four torpedoes against separate targets and can also launch unguided torpedoes or mines.

Manufacturer/Contractor
Ferranti Naval Systems, Portsmouth, UK.

RADAR

Thomson-CSF DRUA-33 (Calypso III)

DRUA-33 radar (also known as Calypso III) carries out airspace and surface surveillance while the submarine is on the surface, and is also used for navigation. There is a single operating console below and the rotating antenna is positioned atop a mast to give maximum coverage.

Specifications
Role: Surveillance and navigation
Frequency bands: I/J
Gain: >29 dB

Pulse: 0.15/0.5 µs
Peak output power: 70 kW
Range: 17 n miles (31 km) for 10 m² target

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

SONAR

STN Atlas DBQS-21F (CSU-83/1)
The DBQS-21 (CSU-83) sonar suite is designed for submarines of 400 tonnes displacement and upwards, and is the primary sensor of the submarine fire control and command system of the German Navy. It comprises a passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array covering the frequencies 10 Hz to 2 kHz, a towed array, and two self-noise detectors. The system is claimed to provide high probability of detection over 360°.

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

PERISCOPES

Kollmorgen Model 76
Two Kollmorgen Model 76 periscopes, one for search, the other for attack.

Specifications
Magnification/Field of View: 1.5×; FOV 32°; 6×; FOV 8°
Elevation:
search version: +60 to −10°
attack version: +74 to −10°

Manufacturer/Contractor
Kollmorgen Electro Optical, Northampton, Massachussets, USA.

PROPULSION

Specifications
System: Diesel-electric
Main engines: 4 MTU 12V 493 AZ80 GA31L diesels; 1.76 MW (2,400 hp(m))
Alternators: 4 Siemens alternators; 1.8 MW;
Electric motor: 1 Siemens motor; 3.38 MW (4,600 hp (m)) sustained
Shaft: 1
Batteries: Very high-capacity batteries with GRP lead-acid cells by Varta/Saturnia

FURTHER INFORMATION

PROGRAMME

The Brazilian Navy is expanding slowly but steadily, and one well-established aim is to develop nuclear-powered attack submarines (SSNs). A powerful team is developing the nuclear propulsion system, while a submarine production facility has been established in the navy yard at Rio de Janeiro. The nuclear project is, however, taking much longer than had been anticipated and it now looks likely that it will come to fruition around 2011 rather than 2001, as planned.

In the shorter term a fifth 'Tupi' class (Type 209/1400) has been ordered and it is highly probable that a new class of Brazilian-designed diesel-electric submarines will be built: the 'Improved 'Tupi' class'.

DESIGN

The new submarine is being designed by the Naval Engineering Directorate.

GOLF

GENERAL SPECIFICATIONS

Country: People's Republic of China (PRC)

Class: GOLF

Built: 1
In service: 1

Displacement:
surfaced: 2,350 t
submerged: 2,950 t

Dimensions
Length: 99 m (324.8 ft)
Beam: 8.6 m (28.2 ft)
Draught: 6.6 m (21.7 ft)

Speed:
surfaced: 17 kts
submerged: 13 kts
Range (surfaced): 6,000 n miles at 15 kts

Complement: 86 (12 officers)

SUBMARINES

200
Builder Dalien Shipyard, China
Launched Sep 1966

WEAPONS SYSTEMS

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBM)

Ju Lang (JL)-2 (CSS-NX-4)
There is one, vertically mounted launch tube in the sail for the JL-2 SLBM. JL-2 (Ju Lang = Giant Wave) is the first second-generation PLA-N SLBM and is reported to be a two-stage (possibly three-stage), solid fuel missile with a range of some 4,320 n miles (8,000 km). The JL-2 is scheduled to equip the new PLA-N SSBNs and may also be retrofitted to the current 'Daqingyu' (Xia) class SSBNs. Payload will probably be either a single 250 kT warhead or three/four 90 kT MIRVs.

Specification (estimated)
Length: n/k
Diameter: n/k
Launch weight: n/k
Payload: 1—250 kT or 3/4—90 kT MIRV
Propulsion: Solid
Stages: 2
Range: 4,320 n miles (8,000 km)
Status: In development
In-service date: 1998

TUBES

10—533 mm (21 in) tubes; six bow, four stern.
Total weapon load, 12.

TORPEDOES

Type SAET-60
This submarine is armed with Russian-supplied SAET-60 anti-surface torpedoes.

Specifications
Length: 7.8 m (25.6 ft)
Diameter: 533 mm (21 in)
Propulsion: Electric
Performance: 15 km at 40 kts
Guidance: Passive
Warhead: 400 kg (882 lb)

COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Plate
The Snoop Plate, I-band, surface search radar was one of the early Soviet (Russian) post-war designs.

Specifications
Band: I
Peak power: 80 kW
Pulsewidth: 1-2 µs
Pulse repetition frequency: 1,618 pps
Scan rate: 10 or 20 rpm

SONAR

Feniks
Feniks (Phoenix) is known to NATO as 'Pike Jaw' and is the array mounted in a dome atop the bow. It is an active/passive search and attack sonar, operating at medium frequency. It is manufactured in the PRC.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 3 Type 37-D diesels; 4.41 MW (6000 hp(m))
Electric motors: 3—4 MW (5,500 hp(m))
Shafts: 3
Propellers: 3

FURTHER INFORMATION

PROGRAMME

The Soviet 'Golf I' class diesel-electric submarines were built between 1958 and 1962 to launch three SS-N-4 Sark missiles from vertical launch tubes mounted in the sail. This submarine was built in China under licence and launched in 1966, and is similar to, but not identical with, the Soviet 'Golf' class. It has been used as a trials boat throughout its life.

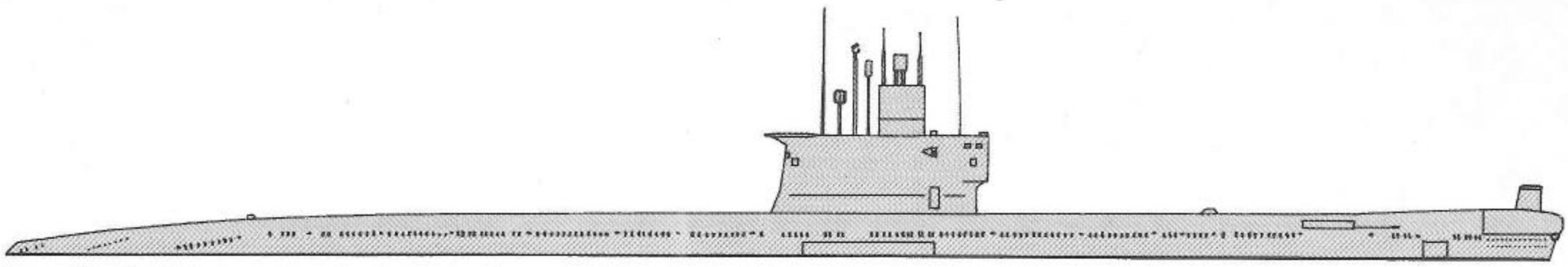
The missile tubes are mounted vertically in the sail. As built, there were two tubes (compared to three in the Russian 'Golf' class boats) probably because the Chinese JL-1 had a larger diameter than the Russian SS-N-5. The JL-2 is, however, larger still and only one is mounted in the sail.

OPERATIONAL

The original employment of this boat was in trials of the JL-1 (CSS-N-3) SLBM, the first successful launch being in October 1982, when the missile attained a range of 1,800 km. The boat continues to be used as a trials platform and is reported to be involved in the trials programme for the JL-2 SLBM. No live launch has actually been confirmed, although an underwater launch of JL-2 was reported in 1985 and it is difficult to see what other platform could have been used.

Although used as a trials submarine, it could, in an emergency, be used in an operational role.

ROMEO



Romeo (Ian Sturton)

OVERVIEW

The 'Romeo' class was originally produced for the Soviet Navy in the late 1950s, and was a Soviet development of the 'Whiskey' class. As the table shows, the Romeo was no longer than the Whiskey, but had greater volume and a considerably greater diving depth. A significant improvement was two extra bow torpedo tubes, although there were no extra reloads.

20 were built for the Soviet Navy at Gor'kiy between 1958 and 1962 and following their service in the Soviet Navy a number were transferred to foreign navies:

Algeria: 2
Bulgaria: 4 (1971-72 — 2; 1985 — 1; 1986 — 1)
Egypt: 6
Syria: 2

Meanwhile, the Chinese had started licence production of the Romeo, with the first boat being launched in 1962. At the start production was at Jiangnan shipyard, Shanghai, but production later switched to Wuhan, ending in about 1984. 84 boats were built for the PLA-N and a number, all new construction, were also exported:

North Korea — 7 (1973-75)
Egypt — 4 (1982 — 2; 1984 — 2)

Construction in the PRC ended about 1984-87 when the Ming programme restarted.

The 'Romeo' class is a very old-fashioned design, based on that of the Whiskey, which was itself a development of the German Type XXI. Compared with the Whiskey, the Romeo has two more bow torpedo tubes, a more streamlined hull-form, and more powerful electric motors. The original Chinese versions were probably identical copies, but undoubtedly there will have been some developments over such a long production run and there are probably some dimensional variations between newer and older boats in the class. Most of the Romeos appear likely to be retired over the next few years, but the Egyptian boats are undergoing such a thorough refit that it seems likely that they will serve until 2010, at least.

TABLE I: Whiskey V and Romeo submarine characteristics

	Whiskey V	Romeo
Displacement		
surfaced	1,080 t	1,475 t
submerged	1,350 t	1,830 t
Dimensions		
length	76 m (249.3 ft)	76.6 m (251.3 ft)
beam	6.5 m (21.3 ft)	6.7 m (22 ft)
draught	4.9 m (16.1 ft)	5.2 m (17.1 ft)
Speed		
surfaced	18 kts	15.2 kts
snorting	7 kts	10 kts
dived	14 kts	—
submerged	—	13 kts
Range		
surfaced	8,500 n miles at 10 kts	9,000 n miles at 9 kts
Diving depth	170 m (560 ft), but reduced by age	300 m (984 ft)
Endurance	40-45 days	55-60 days
Torpedo tubes		
(torpedoes)	4 bow; 2 stern (12)	6 bow; 2 stern (14)
Complement	54	54 (10 officers)

ROMEO, BULGARIA

GENERAL SPECIFICATIONS

Country: Bulgaria

Class: ROMEO

Transferred: 4
In service: 2

Displacement:
surfaced: 1,475 t
submerged: 1,830 t

Dimensions
Length: 76.6 m (251.3 ft)
Beam: 6.7 m (22 ft)
Draught: 5.2 m (17.1 ft)

Speed:
surfaced: 15.2 kts
snorting: 10 kts
submerged: 13 kts
Diving depth: 300 m (984 ft)
Range, surfaced: 9,000 n miles at 9 kts

Complement: 54 (10 officers)

SUBMARINES

Nadezhda (83)
Builder Gorkiy, Russia
Transferred 1985

Slava (84)
Builder Gorkiy, Russia
Transferred 1985

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) tubes: six bow, two stern.
Total weapon load, 14.

TORPEDOES

Specifications
SAET-60
Role: Anti-ship

Diameter: 533 mm
Length: 7.8 m
Propulsion: Electric
Speed: 40 kts
Range: 8.1 n miles (15 km)

Guidance: Passive
Warhead: 400 kg

MINES

28 in lieu of torpedoes.

COMMAND AND CONTROL SYSTEMS

RADARS

Snoop Plate or Snoop Tray; I band.

SONARS

Herkules
Herkules is a Soviet-designed high-frequency search sonar and is mounted in the bows underneath the horizontal dielectric silver-coloured strip.

Tamir 5
Tamir 5 was introduced in the Soviet fleet in the 1950s as a high-frequency search sonar and may still be found in some Romeos in place of the Herkules.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 Type 37-D diesels; 2.94 MW (4,000 hp(m))
Electric motors: 2 motors; 1.98 MW (2,700 hp(m))
Creep motors: 2
Shafts: 2
Batteries: 224 cells; 6,600 Ah

FURTHER INFORMATION

PROGRAMME

The Bulgarian Navy has received a total of four Romeos from the Soviet Navy: two in 1971-72; one in 1985 and one in 1986. An order for two 'Kilo' class submarines was placed, but subsequently cancelled.

OPERATIONAL

There are now only two boats remaining operational, both based at Varna, although even these are probably restricted to diving to about 50 m (165 ft).

ROMEO, PEOPLE'S REPUBLIC OF CHINA (PRC)

GENERAL SPECIFICATIONS

Country: People's Republic of China (PRC)

Class: ROMEO
Type: ES3B (previously Type 031)

Built: 95 approximate
In service: 30
Reserve: 35

Displacement:
surfaced: 1,475 t
submerged: 1,830 t

Dimensions
Length: 76.6 m (251.3 ft)
Beam: 6.7 m (22 ft)
Draught: 5.2 m (17.1 ft)

Speed:
surfaced: 15.2 kts
snorting: 10 kts
submerged: 13 kts
Diving depth: 300 m (984 ft)
Range, surfaced: 9,000 n miles at 9 kts

Complement: 54 (10 officers)

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) tubes: six bow, two stern.
Total weapon load, 14.

TORPEDOES

Specifications
SAET-60
Role: Anti-ship
Diameter: 533 mm
Length: 7.8 m (25.6 ft)
Propulsion: Electric
Speed: 40 kts
Range: 8.1 n miles (15 km)
Guidance: Passive
Warhead: 400 kg (882 lb)

MINES

28 in lieu of torpedoes.

COMMAND AND CONTROL SYSTEMS

RADARS

Snoop Plate or Snoop Tray; I band.

SONARS

Herkules
Herkules is a Soviet-designed high-frequency search sonar and is mounted in the bows underneath the horizontal dielectric silver-coloured strip.

Tamir 5
Tamir 5 was introduced in the Soviet fleet in the 1950s as a high-frequency search sonar and may still be found in some Romeos in place of the Herkules.

Thomson-Sintra DUUX-5 Fenelon
DUUX-5 is fitted in some of the Chinese Romeos. This panoramic sonar is capable of automatic, simultaneous tracking of three targets and incorporates a passive acoustic rangefinder for measuring the range of three targets within 120° sectors, and a panoramic sonar interceptor measuring the true bearing of all sonar transmissions received in the 2-15 kHz band. It enables range and bearing information on targets to be obtained by the submarine without the need for any transmissions and with minimum delay. Speed of operation permits target course and speed to be computed rapidly, also allowing any changes in either speed or course to be detected without delay. Four targets can be tracked simultaneously (three on radiated self-noise, one on sonar pulses), and there is a continuous panoramic bearing display over 360°. Range information is provided over arcs of 120° on each side of the submarine. Target data is automatically transmitted to the ship's weapon control system and plotting table. Under normal conditions, results in the middle sector are 0.3° for bearing accuracy, 2° discrimination accuracy between two targets and 5 per cent of range on radiated noise for a target at 10 km distance. Two types of hydrophones are available. The hydrophonic unit is composed of two bases with three hydrophones each on the starboard and port sides of the submarine. All other technical details remain classified.

Manufacturer/Contractor
Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, France.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 Type 37-D diesels; 2.94 MW (4,000 hp(m))
Electric motors: 2 motors; 1.98 MW (2,700 hp(m))

Creep motors: 2
Shafts: 2
Batteries: 224 cells; 6,600 Ah

MODERNISATION

Some of the boats still in service are having battery refits and the more modern boats have a French passive ranging sonar. It has also been reported that Italian *Whitehead 244S torpedoes may have been purchased*, but this has not been confirmed.

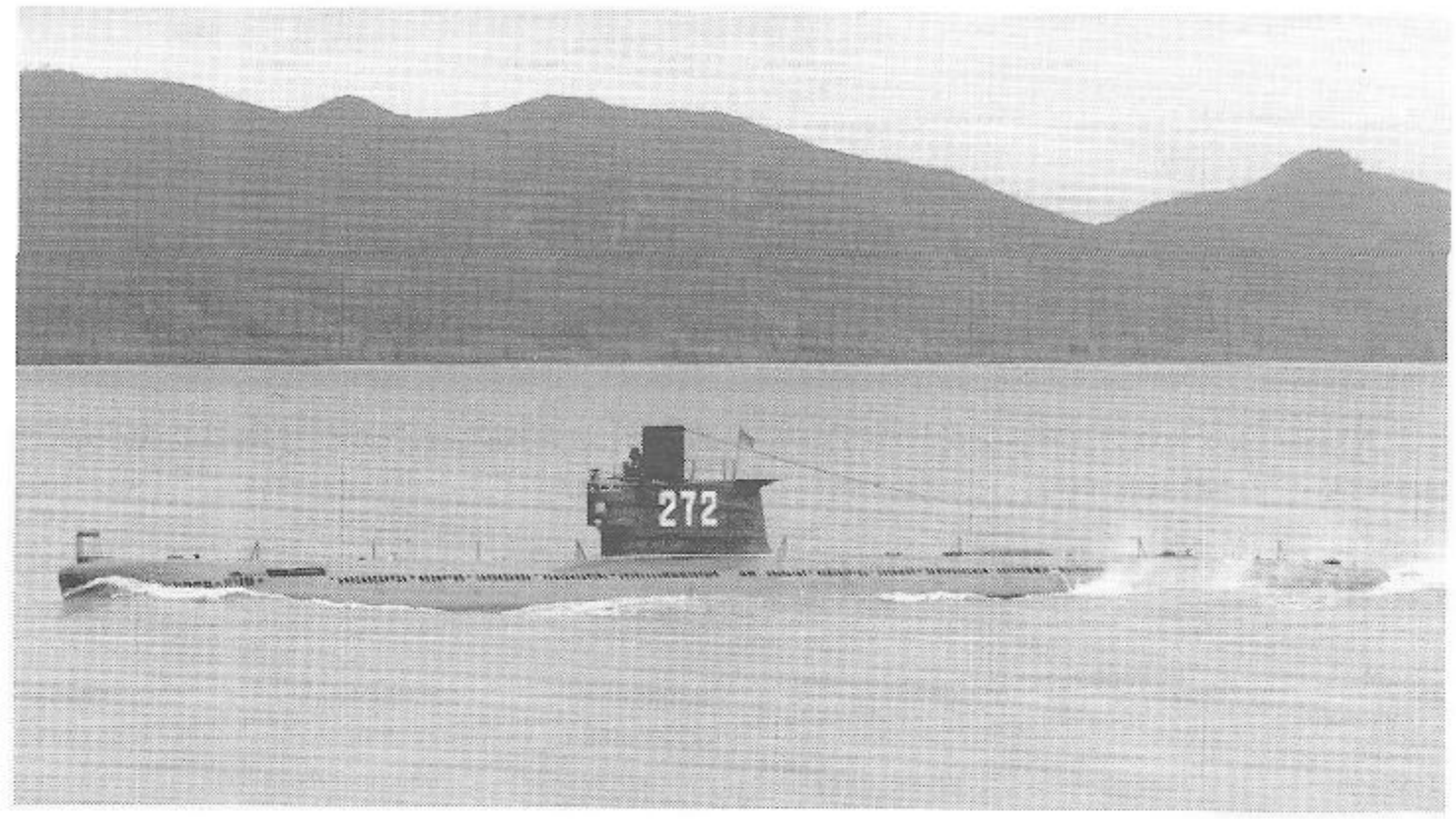
OPERATIONAL

Operational numbers are difficult to assess as no submarine spends more than a few days at sea in each year, due to the shortage of trained men. Of the original 84, some have been stricken and at least 35 are in various states of operational reserve.

These boats have a minimal ASW capability and would stand little chance against modern ASW defences.

The submarines in commission are split between the three fleets and wear pennant numbers in the 200 and 300 series.

FURTHER INFORMATION



'Romeo' class submarine of the People's Liberation Army — Navy off the Chinese coast. Approximately 30 of the elderly boats remain in service (H & L van Ginderen Collection)

ROMEO (MODERNISED), EGYPT

GENERAL SPECIFICATIONS

Country: Egypt

Class: ROMEO

Transferred: 10 (Russia — 6; China — 4)
In service: 4

Displacement:
surfaced: 1,475 t
submerged: 1,830 t

Dimensions
Length: 76.6 m (21.3 ft)
Beam: 6.7 m (22 ft)
Draught: 4.9 m (16.1)

Speed:
surfaced: 16 kts
submerged: 13 kts
Range, surfaced: 9,000 n miles at 9 kts

Complement: 54

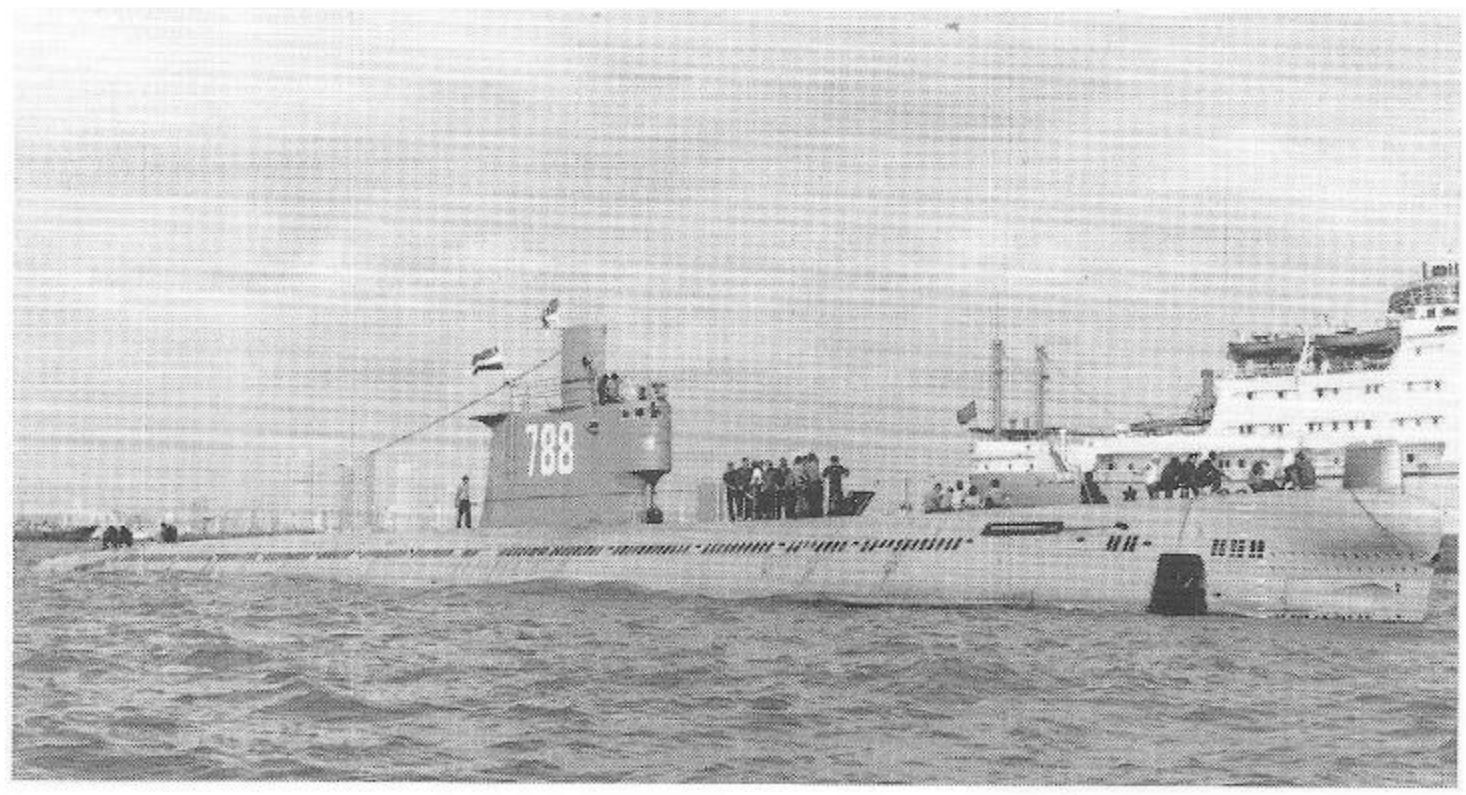
SUBMARINES

849
Builder Wuhan, China
Completed 1980
Transferred to Egypt 22 Mar 1982

852
Builder Wuhan, China
Completed 1980
Transferred to Egypt 22 Mar 1982

855
Builder Wuhan, China
Completed 1980
Transferred to Egypt 21 May 1984

858
Builder Wuhan, China
Completed 1980
Transferred to Egypt 21 May 1984



Egyptian Romeo 788 was one of the Soviet-supplied submarines, but the Chinese-built boats are identical in appearance (H & L van Ginderen Collection)

WEAPONS SYSTEMS

ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Sub-Harpoon

Sub-Harpoon is the main weapon system of the Egyptian modernised Romeos. These are probably Block 1C, which includes a number of options, including the ability to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses, or to approach the target indirectly, using up to three preselected waypoints. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 kg)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

Eight 533 mm (21 in); six bow, two stern.
Total weapon load, 14.

TORPEDOES

The original Romeos were armed with Soviet (and Chinese copies of Soviet) torpedoes. The modernised submarines are, however, now armed with either Sub-Harpoon (see left) or Alliant TechSystems Mk 37F Mod 2 torpedoes.

Alliant NT 37F Mod 2

The NT 37F is a dual-purpose 485 mm diameter ASW and anti-ship torpedo and is a total redesign of the original US Navy Mk 37 torpedo, the only original element common to both being the torpedo hull. All the internal subsystems, including propulsion, sonar and guidance, have been completely replaced by new hardware and software. Compared to previous models, the new Otto-fuelled, thermochemical propulsion system gives a 40 per cent increase in speed, a 150 per cent increase in range, and an 80 per cent increase in endurance. A solid-state acoustic system and a noise-reduction, laminar-flow nose assembly replace the Mk 37's vacuum-tube acoustic panel and hemispherical nose. A new sonar substantially improves passive detection range against high-speed surface targets and active detection range against small silhouette submarine targets; in most cases, target acquisition range has been doubled. The new self-noise reduction nose assembly increases transducer isolation while reducing flow noise effects, thus reducing the likelihood of self-decoying at all depths. Deliveries of the NT 37F Mod 2 to Egypt began in 1994.

Specifications

NT 37F Mod 2
Guidance: wire-guided
Length: 4,505 mm
Diameter: 485 mm (fits 533 mm launch tubes)
Weight: 750 kg
Run modes: Straight run/salvo anti-ship; straight run with acoustic miss indicator to initiate acoustic re-attack; active snake and circle — ASW; passive snake and circle — anti-ship
Warhead: 150 kg HE
Fuze: Contact and proximity
Propulsion: Thermochemical rotary piston cam engine with Otto fuel

Manufacturer/Contractor

Alliant Techsystems, Marine Systems, Hopkins, Minnesota, USA.

MINES

28 tube-launched mines may be carried in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Racal; radar warning.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Singer Librascope Mk 2 (after modernisation).

Loral PISCES command system

The four Chinese-made Romeos are being fitted with PISCES (Paramax International Submarine Combat Information and Engagement System), which was developed by Unisys (formerly Paramax) before being taken over by Loral. This 'third-generation' system incorporates 'state-of-the-art' technologies such as VME bus structure, Motorola 680X0 processors, RISC processors, UNIX, Vx works and C.

PISCES processes data gathered by 'own ship' tracking sensors (sonar, radar, ESM, CCTV and periscopes), navigation system sensors (speed log, gyrocompass, GPS and Inertial Navigation System (INS)) and communications systems (datalink, RDF and IFF). These data are recorded, analysed and manipulated by PISCES operators to assess potential adversary capabilities and co-ordinate manoeuvring of the submarine and deployment of its weapons. Over 200 tracks from multiple sources can be handled using automatic and manual Target Motion Analysis (TMA) techniques, while the weapon launch and control portion provides simultaneous control of multiple weapon types in virtually any mix (including salvos of the same weapon) for use against a single or multiple threats.

PISCES also provides a data extraction and playback function for recording mission-critical data for later replay and analysis, system training function to maintain system operator proficiency, piloting and prediction functions to aid in the manoeuvring and navigation of the ship, environmental/oceanography functions to aid in determining ship operating environment and an optional overlay/cartographic function.

Four systems were ordered by the Egyptian Navy and installation is now complete.

Manufacturer/Contractor

Loral Systems Group, Litchfield Park, Arizona, USA.

RADAR

Snoop Plate

The Snoop Plate, I-band, surface search radar was one of the early Soviet (Russian) post-war designs.

Specifications

Band: I
Peak power: 80 kW
Pulsewidth: 1-2 µs
Pulse repetition frequency: 1,618 pps
Scan rate: 10 or 20 rpm

SONARS

Herkules

Herkules is a Soviet-designed high-frequency search sonar and is mounted in the bows underneath the horizontal dielectric silver-coloured strip.

STN Atlas CSU-83/1

The CSU-83 (DBQS-21) sonar suite is designed for submarines of 400 tonne displacement and upwards, and is the primary sensor of the submarine fire-control and command system of the German Navy. It comprises a passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array covering the frequencies 10 Hz to 2 kHz, a towed array, and two self-noise detectors. The system is claimed to provide high probability of detection over 360°.

Manufacturer/Contractor

STN Atlas Elektronik, Bremen, Germany.

PROPULSION

Specification

System: Diesel-electric
Main Machinery: 2 Type 37-D diesels; 2.94 MW (4,000 hp(m))
Electric motors: 2—1.98 MW (2,700 hp(m))
Shafts: 2
Creep motors: 2

FURTHER INFORMATION

PROGRAMME

The Egyptian Navy originally obtained its 'Romeo' class submarines from the USSR, five in 1966 and the sixth in 1969, all having previously been in service with the Soviet Navy. The two countries then fell out with each other and Egypt turned to China for further submarines, with two being commissioned in 1982 and another two in 1984, all being new builds.

Egyptian Romeo in Alexandria harbour. (Note that ship on right is the Italian-built AOR Agnadeen *which was intended for Iraq but has been laid-up in Alexandria since 1986)*

MODERNISATION

The Egyptian Navy has instituted a plan to give the Chinese-supplied boats a full modernisation, with two of the Russian boats receiving a very limited upgrading pending the completion of work on the Chinese boats.

A five-year contract was signed with Tacoma, Washington in early 1988 to retrofit the ex-Chinese submarines to enable them to carry and launch Sub-Harpoon and Mk 37F wire-guided torpedoes. Other work includes installing Loral active sonar, ARGOSystems ESM systems, and Atlas Elektronik passive sonar and fire-control system. The US Congress did not give approval to start work until July 1989 and then the prime contractor suffered financial problems. The prime contractor is now Loral.

OPERATIONAL

Two ex-Soviet submarines were stricken in 1989 and of the remaining four ex-Soviet boats, the last two were stricken in 1996. Of the Chinese-supplied submarines, 855 was the first to complete modernisation and was active again in late 1994. All are based at Alexandria.

ROMEO, NORTH KOREA

GENERAL SPECIFICATIONS

Country: North Korea

Class: ROMEO
Type: 031

Built: 22
In service: 22
Building: 2 (?)

Displacement:
surfaced: 1,475 t
submerged: 1,830 t

Dimensions
Length: 76.6 m (251.3 ft)
Beam: 6.7 m (22 ft)
Draught: 5.2 m (17.1 ft)

Speed:
surfaced: 15 kts
submerged: 13 kts
Range, surfaced: 9,000 n miles at 9 kts
Diving depth: 270 m (886 ft)

Complement: 54 (10 officers)

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) tubes; six bow, two stern.
Total weapon load, 14.

TORPEDOES

The weapons in these submarines are probably Soviet SAET-60, supplied by the PRC

Specifications
SAET-60
Role: Anti-ship
Diameter: 533 mm
Length: 7.8 m
Propulsion: Electric

Speed: 40 kts
Range: 8.1 n miles (15 km)
Guidance: Passive
Warhead: 400 kg

MINES

28 in lieu of torpedoes.

COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Plate
The Snoop Plate, I-band, surface search radar was one of the early Soviet (Russian) post-war designs.

Specifications
Band: I
Peak power: 80 kW
Pulsewidth: 1-2 µs

Pulse repetition frequency: 1,618 pps
Scan rate: 10 or 20 rpm

SONARS

Tamir 5L
Tamir 5L is a hull-mounted, active sonar operating at 24 kHz.

Feniks
Feniks (Phoenix) is known to NATO as 'Pike Jaw' and is the array mounted in a dome mounted on the bow. It is an active/passive search and attack sonar, operating at medium frequency. It is manufactured in the PRC.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 Type 37-D diesels; 2.94 MW (4,000 hp(m))

Electric motors: 2—1.98 MW (2,700 hp(m))
Shafts: 2
Creep motors: 2

FURTHER INFORMATION

PROGRAMME

Two Chinese-built Romeos were transferred to North Korea in 1973, followed by a further two in 1974 and three in 1975. Production in North Korea then started at two shipyards, at Sinpo and Mayang-do, with the first three being completed in 1976. Since then construction has continued at a rate of about one every 14 months, although it may have ended in 1995.

OPERATIONAL

Four of the ex-Chinese units are based on the west coast, but the majority of these boats are stationed on the east coast and are occasionally seen operating in the Sea of Japan.

By modern standards these are basic attack submarines only suitable for attacks on surface shipping and with virtually no anti-submarine performance or potential. They could, however, be a considerable nuisance in a conflict, if only through sheer weight of numbers.

One was reported to have sunk in February 1985.

ROMEO, SYRIA

GENERAL SPECIFICATIONS

Country: Syria

Class: ROMEO

Bought: 3
In service: 1 (?)

Displacement:
surfaced: 1,475 t
submerged: 1,830 t

Dimensions
Length: 76.6 m (251.3 ft)
Beam: 6.7 m (22 ft)
Draught: 4.9 m (16.1 ft)

Speed:
surfaced: 16 kts
submerged: 13 kts
Range, surfaced: 9,000 n miles at 9 kts
Endurance: 60 days

Complement: 54

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in); six bow, two stern.
Total weapon load, 14.

TORPEDOES

Specifications
SAET-60
Role: anti-ship
Diameter: 533 mm
Length: 7.8 m
Propulsion: Electric
Performance: 8.1 n miles (15 km) at 40 kts
Guidance: Passive
Warhead: 400 kg

MINES

28 in lieu of torpedoes.

COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Plate
I-band search radar.

SONARS

Herkules
Herkules is a Soviet-designed high-frequency search sonar and is mounted in the bows underneath the horizontal dielectric silver-coloured strip.

Tamir 5
Tamir 5 was introduced in the Soviet fleet in the 1950s as a high-frequency search sonar and may still be found in some Romeos in place of the Herkules.

PROPULSION

Specifications
System: Diesel-electric
Main machinery: 2 Type 37-D diesels; 2.94 MW (4,000 hp(m))

Electric motors: 2 motors; 1.98 MW (2,700 hp(m))
Creep motors: 2
Shafts: 2
Battery: 224 cell, 6,600 Ah battery

FURTHER INFORMATION

PROGRAMME

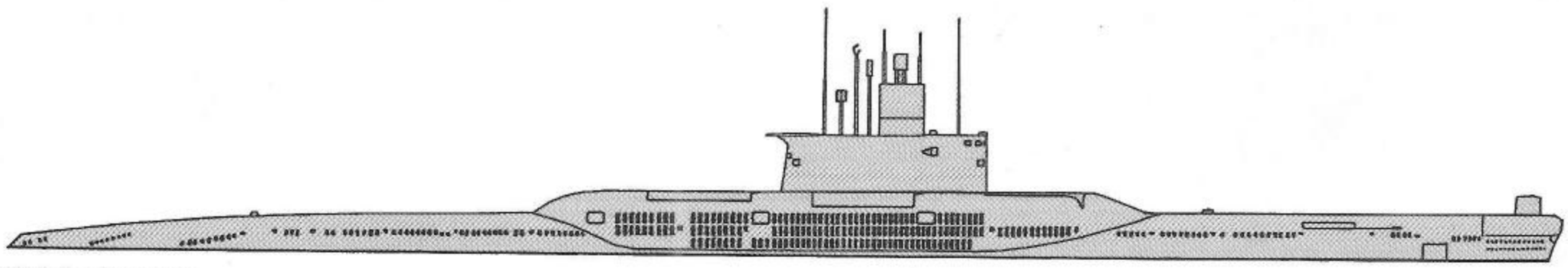
Two arrived in Syrian naval base at Tartous in November 1985 and transferred from the Soviet to Syrian flags after a training period in July 1986. The third boat transferred in December 1986. These were unlikely to have been new construction and were probably completed about 1961.

OPERATIONAL

One of the three is reported to have sunk alongside in 1995, but was subsequently refloated. All are based at Latakia, in the north. None has been to sea for over three years and it is probable that, even if they are capable of putting to sea, they are not fit to dive.

In addition to the three Romeaos, one ex-Russian navy 'Whiskey' class submarine was transferred from the Black Sea fleet in November 1985 and acts as an alongside charging platform.

CONVERTED ROMEO (ES5G)



ES5G (Ian Sturton)

GENERAL SPECIFICATIONS

Country: People's Republic of China (PRC)

Class: CONVERTED ROMEO (SSG)
Type: ES5G

Built: 1
In service: 1

Displacement:
surfaced: 1,650 t
submerged: 2,100 t

Dimensions
Length: 76.6 m (251.3 ft)
Beam: 7.6 m (24.93 ft)
Draught: 5.3 m (17.39 ft)

Speed
surfaced: 15 kts
snorting: 10 kts
submerged: 17 kts

Complement: 58 (10 officers)

SUBMARINES

351
Builder Wuhan shipyard
In service 1987

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Ying Ji (Eagle Strike) C-801 missiles

There are six launchers, three either side of the sail, for C-801 Ying Ji-1 missiles, but it is important to note that target acquisition and missile launch must take place on the surface. The YJ-1 is rocket-propelled with a rocket booster, and on launch it climbs to about 50 m then descends to 20-30 m until its radar seeker has acquired the target. It then descends to 5-7 m using the nose-mounted, monopulse (probably J-band), radar seeker for the terminal approach phase.

Specifications
Length: 5.81 m (19.06 ft)
Diameter: 36 cm (14.17 in)
Wing span: 1.18 m (3.87 ft)
Propulsion: Rocket motor
Weight: 815 kg (1,797 lb)
Range: 4.5-23 n miles (8-42 km)
Speed: Mach 0.9
Guidance: Inertial and active radar
Warhead: 165 kg (363.7 lb) semi-armour-piercing

Manufacturers/Contractors
China Precision Machinery Import and Export Corporation (CPMIEC).

TUBES

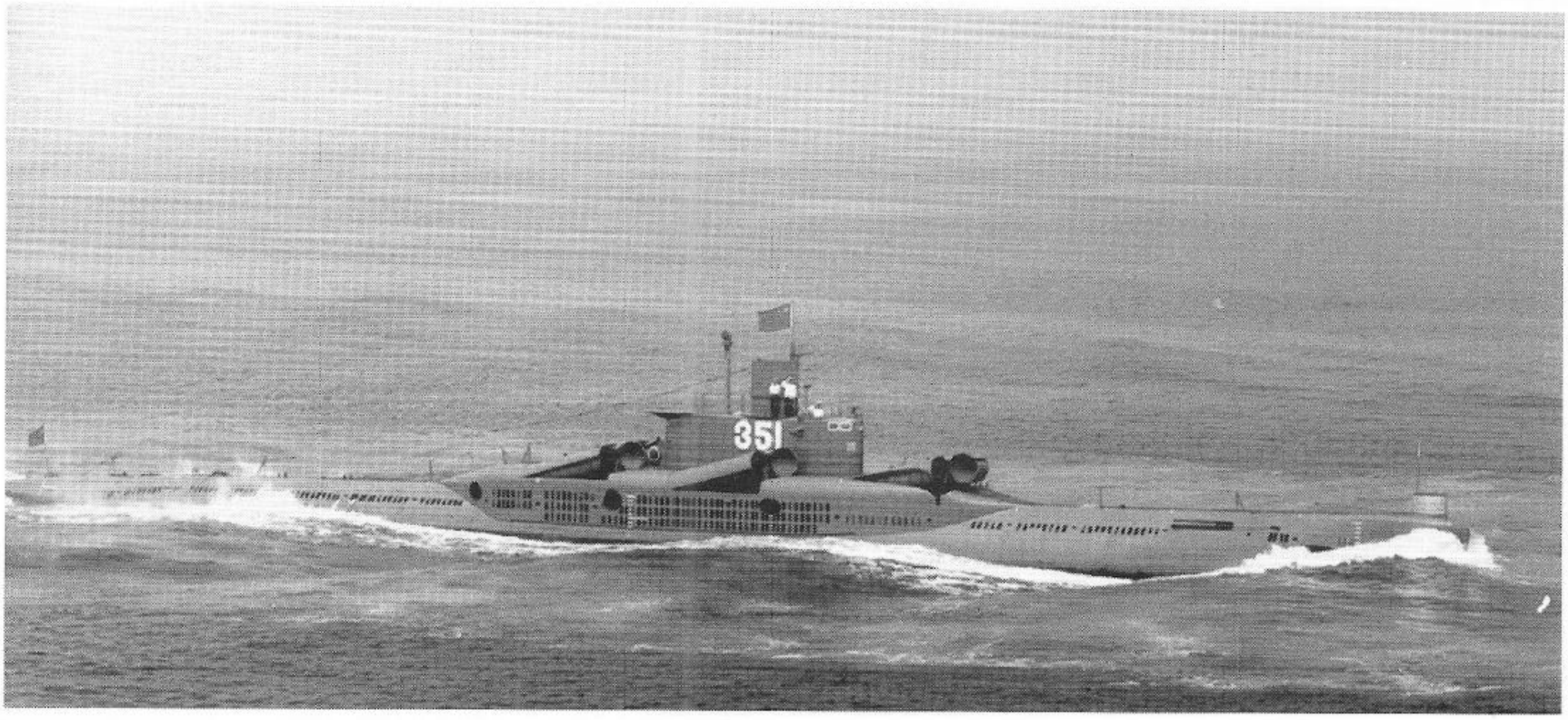
Eight 533 mm (21 in); six bow, two stern.
Number of torpedoes, 16.

TORPEDOES

Specifications
SAET-60
Role: Anti-ship
Diameter: 533 mm
Length: 7.8 m (25.6 ft)
Propulsion: Electric
Speed: 40 kts
Range: 8.1 n miles (15 km)
Guidance: Passive
Warhead: 400 kg (882 lb)

MINES

28 in lieu of torpedoes.



ES5G with all six missile containers raised. The C-801 missiles can only be launched while the submarine is on the surface, making the system relatively vulnerable against a sophisticated enemy. In a regional conflict it would, however, be a potent threat (CPMIEC)

COMMAND AND CONTROL SYSTEMS

RADARS

Snoop Plate

The Snoop Plate, I-band, surface search radar was one of the early Soviet (Russian) post-war designs.

Specifications

Band: I
Peak power: 80 kW
Pulsewidth: 1-2 µs
Pulse repetition frequency: 1,618 pps
Scan rate: 10 or 20 rpm

Snoop Tray

Snoop Tray is a Soviet-designed, I-band, surface search radar. It is unusual to find both Snoop Tray and Snoop Plate in the same submarine and it is assumed that Snoop Tray is used for target acquisition.

SONAR

Feniks

Feniks (Phoenix) is known to NATO as 'Pike Jaw' and is the array mounted in a dome mounted on the bow. It is an active/passive search and attack sonar, operating at medium frequency. It is manufactured in the PRC.

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 2 Type 37-D diesels; 2.94 MW (4,000 hp(m))
Electric motors: 2—1.98 MW (2700 hp(m))
Creep motors: 2
Shafts: 2

FURTHER INFORMATION

PROGRAMME

This design, designated ES5G, is a converted Romeo, which has been rebuilt as a trials platform for the concept of a surface-launched missile platform.. Others may be converted in due course.

DESIGN

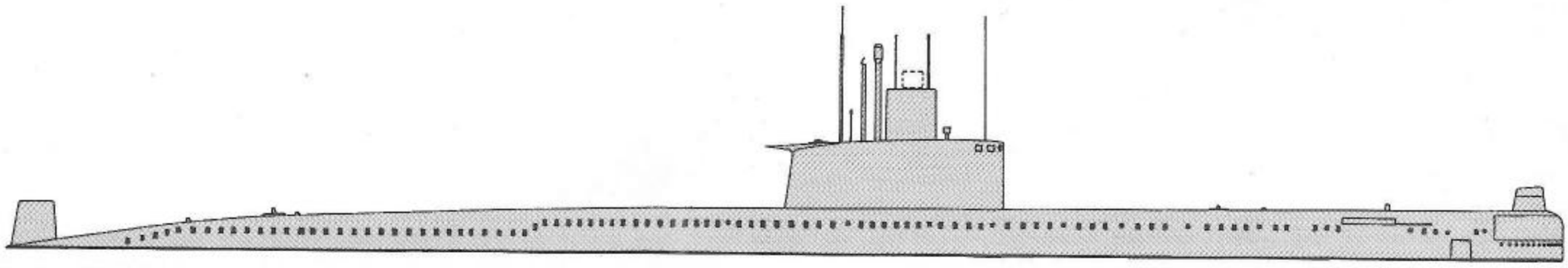
The six launch tubes for the YJ-1 missiles are built into the raised casing abreast the sail. The submarine must surface and then raise the tubes to about 20° prior to launching. To provide target acquisition an additional radar mast (Snoop Tray) is mounted between the two periscopes.

Surface launch of Ying-Ji (C-801) missile. This weapon has a range of 23 n miles and a speed of Mach 0.9 (CPMIEC)

OPERATIONAL

This is essentially a Chinese version of the concept tested in the Soviet Navy by the 'Juliett' class SSGs. Like the Juliett, this Chinese submarine must surface in order to acquire the target and then fire the missiles. This would undoubtedly render the submarine very vulnerable to detection and attack by a sophisticated enemy, but against most Asian navies, particularly those lacking any form of seaborne air surveillance, it could prove highly effective. This submarine is currently stationed with the North China Sea Fleet.

MING (Type 035)



Ming (Ian Sturton)

GENERAL SPECIFICATIONS

Country: People's Republic of China (PRC)

Class: MING
Type: 035

Built: 10
In service: 10
Building: 1

Displacement:
surfaced: 1,584 t
submerged: 2,113 t

Dimensions
Length: 76 m (249.3 ft)
Beam: 7.6 m (24.9 ft)
Draught: 5.1 m (16.7 ft)

Speed:
surfaced: 15 kts
snorting: 10 kts
submerged: 18 kts
Diving depth: 300 m (985 ft)

Range:
snorting: 8,000 n miles at 8 kts
submerged: 330 n miles at 4 kts
Endurance: 60 days

Complement: 55 (9 officers)

SUBMARINES

232; 233; 342; 352; 353; 354; 356; 357; 358; 359

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) tubes; six bow, two stern.
Total weapon load, 16.

TORPEDOES

Specifications
Type SAET-60
Diameter: 533 mm
Length: 7.8 m (25.6 ft)
Propulsion: Electric
Speed: 40 kts
Range: 8.1 n miles (15 km)

Guidance: Passive
Warhead: 400 kg (882 lb)

MINES

28 in lieu of torpedoes.

COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Tray
Snoop Tray is a Soviet-designed, I-band, surface search radar.

SONAR

Feniks
Feniks (Phoenix) is known to NATO as 'Pike Jaw' and is the array mounted in a dome mounted on the bow. It is an active/passive search and attack sonar, operating at medium frequency. It is manufactured in the PRC.

NAVIGATION

Magnavox Satnav.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 diesels; 3.82 MW (5,200 hp(m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

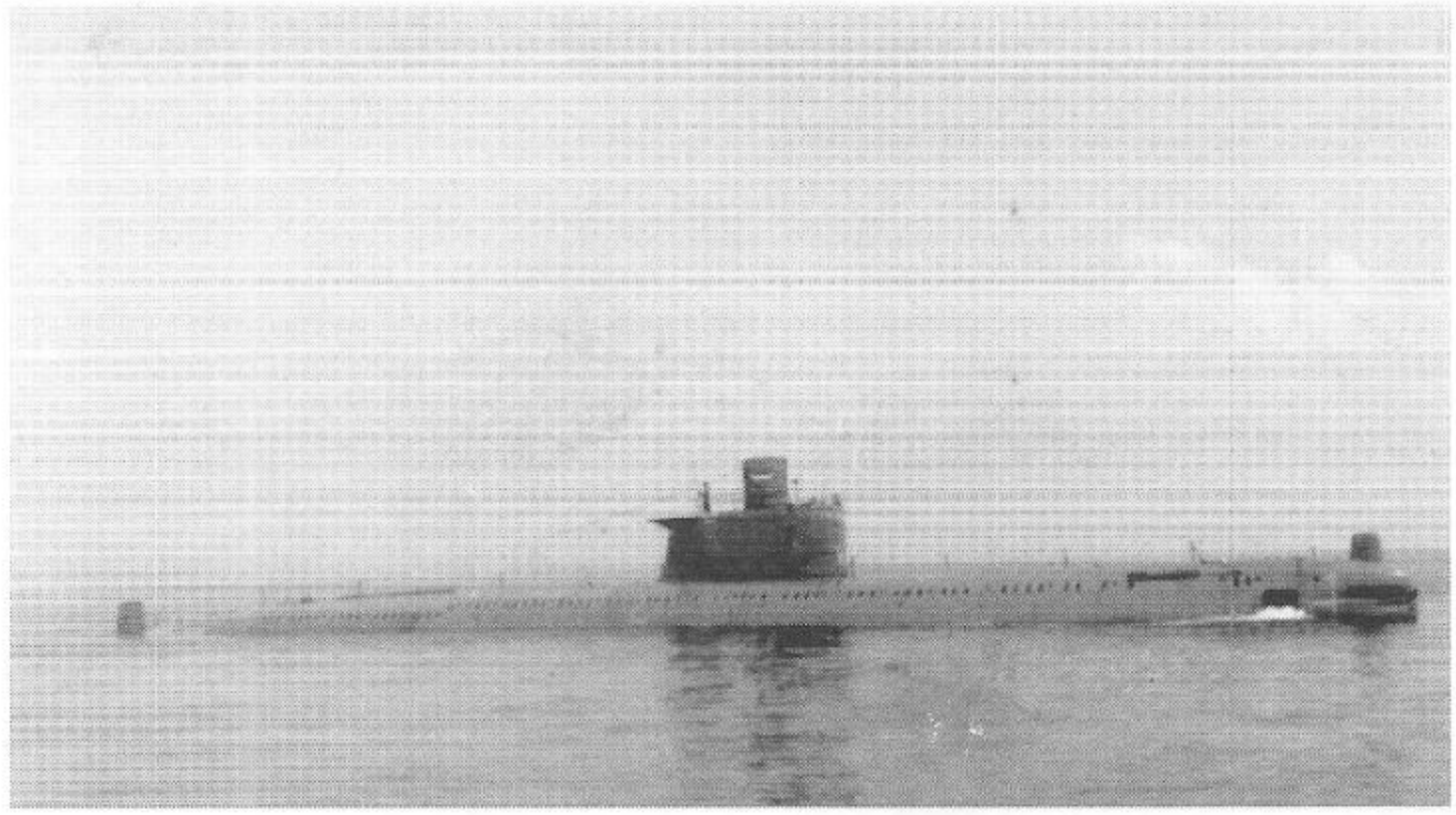
The first three of Type ES5C/D were completed between 1971 and 1979, one of which was scrapped after a fire. There was then a pause and building of a modified design, ES5E, resumed in 1987 at the rate of less than one per year. The programme was thought to have terminated in 1992 but may have continued at a slow pace until work on the new 'Kilo' class began.

MODERNISATION

The 'Ming' class is currently undergoing a modernisation programme and there are unconfirmed reports that this may be with the assistance of Israel.

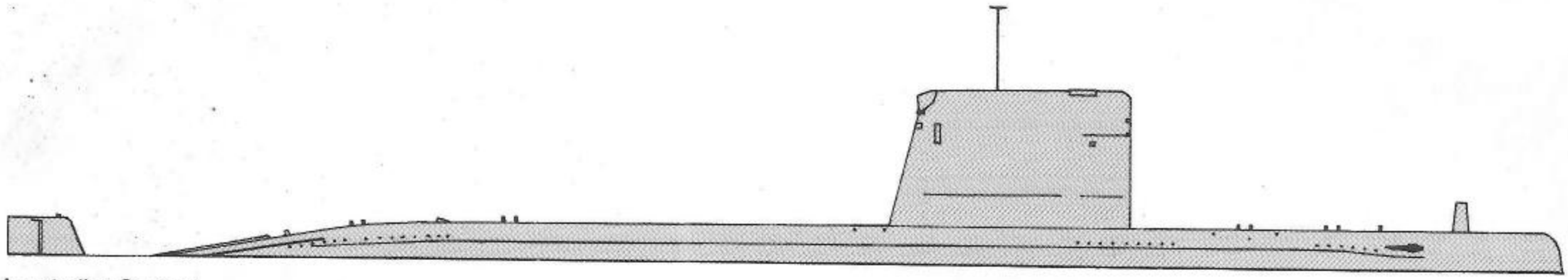
OPERATIONAL

All are active in the East and North China Sea Fleets.



Approximately 10 'Ming' class submarines have been built over a period of some 22 years

AGOSTA



Agosta (Ian Sturton)

OVERVIEW

Construction of the 'Agosta' class was announced in 1970 under France's third five-year new construction plan for 1971-75. Four have also been built by Bazán at Cartagena for the Spanish Navy and two for Pakistan by Dubigeon, France. That appeared to be the end of the story, but in a surprise move three more were ordered 21 September 1994, as described in the following entries.

DESIGN

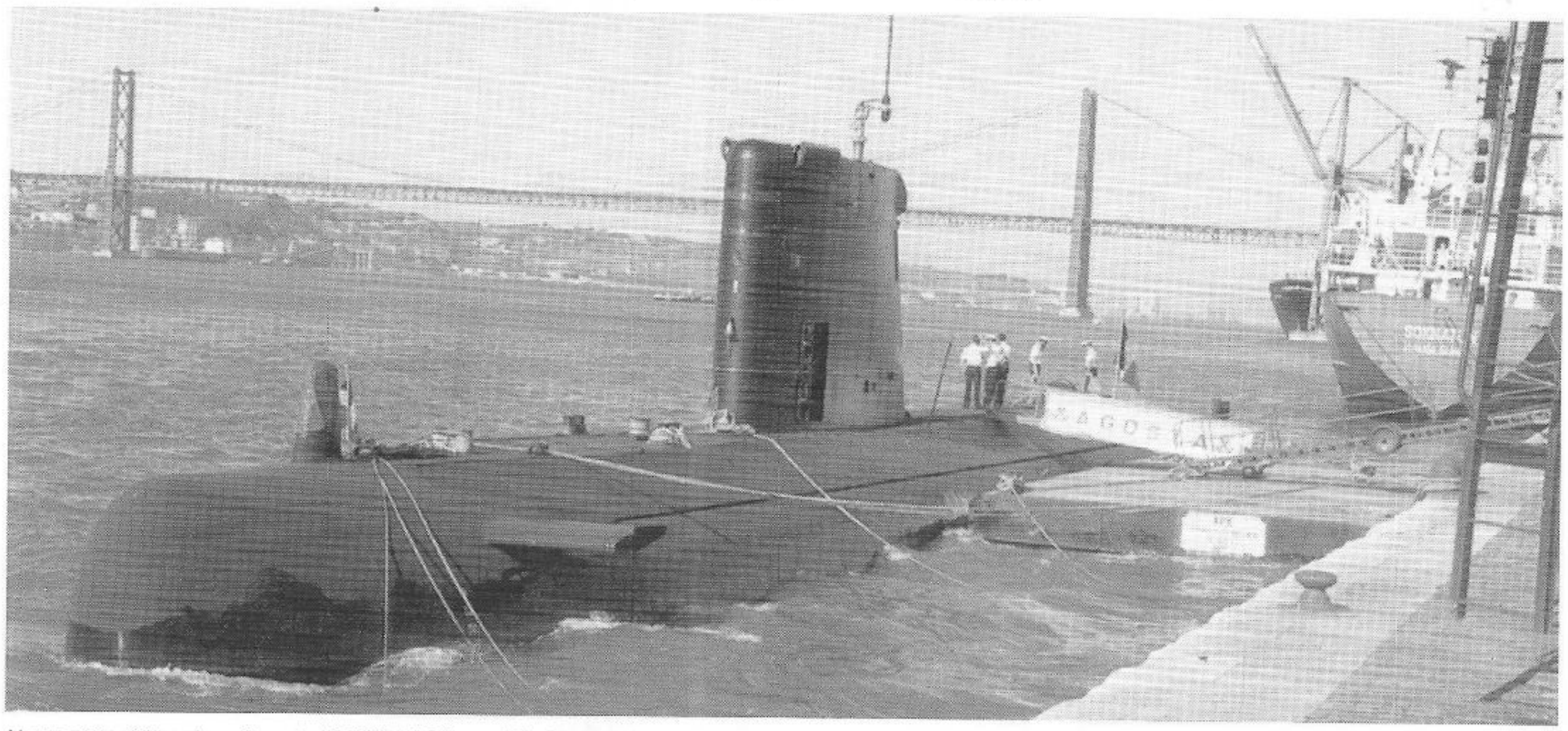
The 'Agosta' class is a double-hulled submarine, of conventional design, somewhat larger than the previous 'Daphné' class and intended for distant-water operations. Considerable efforts were made in the design to improve noise reduction compared to earlier French designs, which included a clean casing, retracting deck fittings, and the damping of internal noise.

Only four torpedo tubes are fitted, one of the smallest batteries in any modern attack submarine. This is, however, offest by the large number of reloads, a total of 20 torpedoes being carried, and a rapid reloading gear.

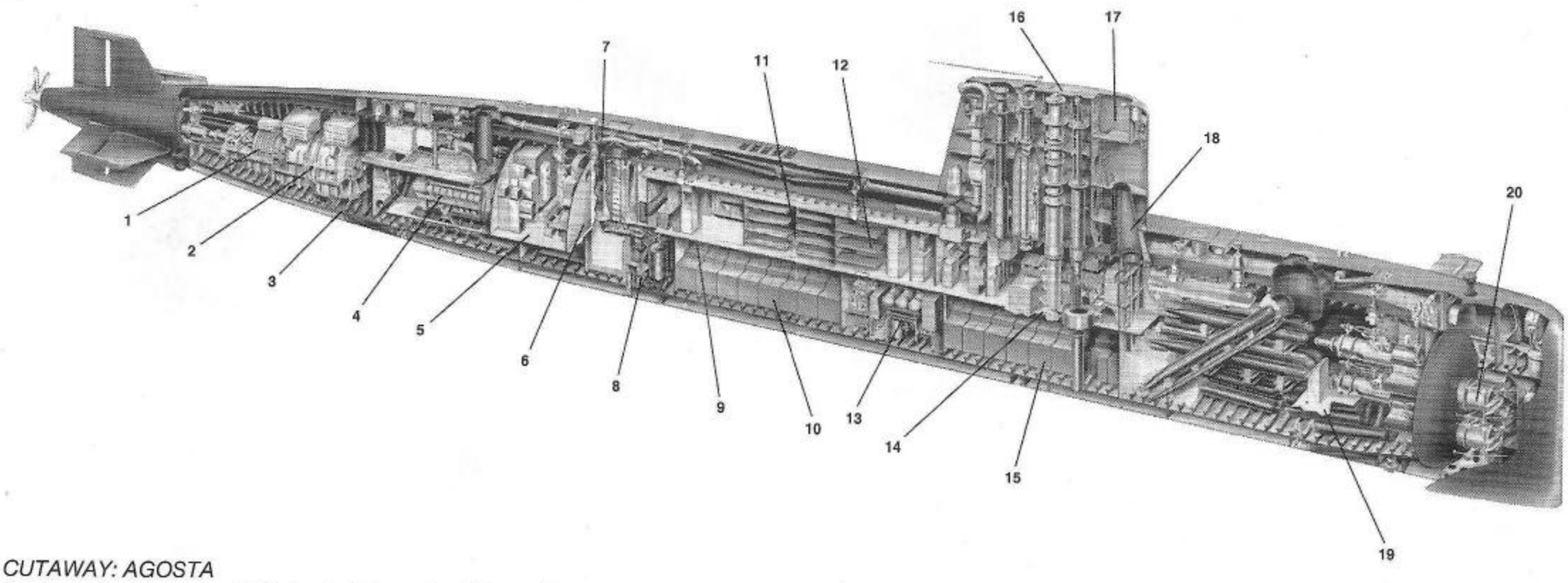
The tubes in this class are 533 mm (21 in) in diameter, the first of this size to be carried by a French submarine, previous designs having had 550 mm (21.7 in) tubes. The Agosta's tubes will, however, still accept the 550 mm torpedoes.

The torpedo launching process involves the torpedo being expelled from the tube by a five-section pneumatic ram, which pushes at the tail end of the torpedo over a stroke of about 4 m (13 ft). The tube comprises an annular section around the torpedo, which enables the seawater to enter through the tube forward door and to equalise the pressure around the torpedo. The ejection speed is thus virtually independent of the actual depth and speed of the submarine, and there is no acoustic signature.

There is a small motor on the main shaft, mounted between the thrust bearing and the main electric motor. This enables the submarine to 'creep' at approximately 1.5 knots at low shaft revolutions, thus minimising the acoustic signature.

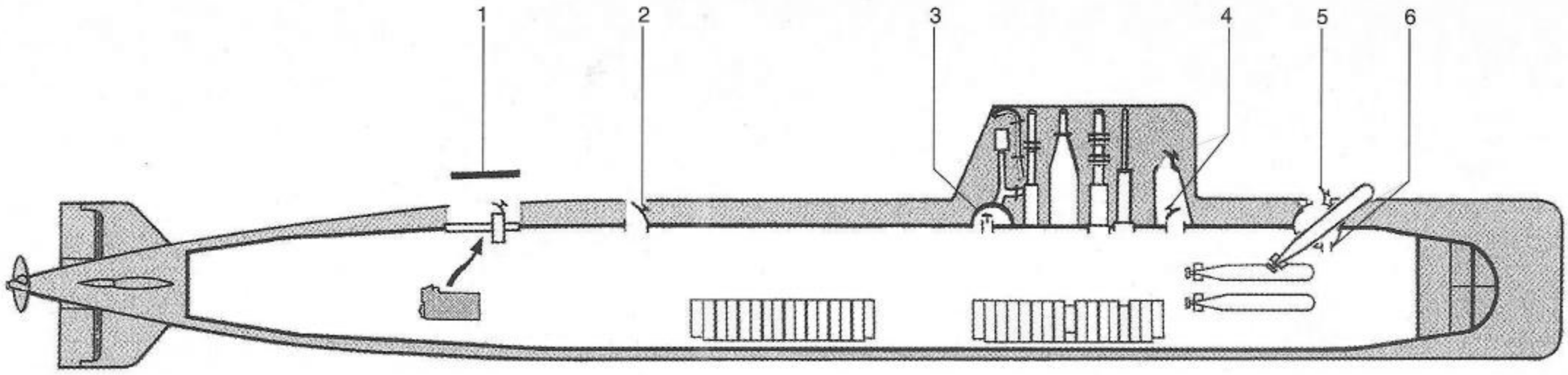


Name ship of the class, Agosta *(S 620)* (H & L van Ginderen Collection)

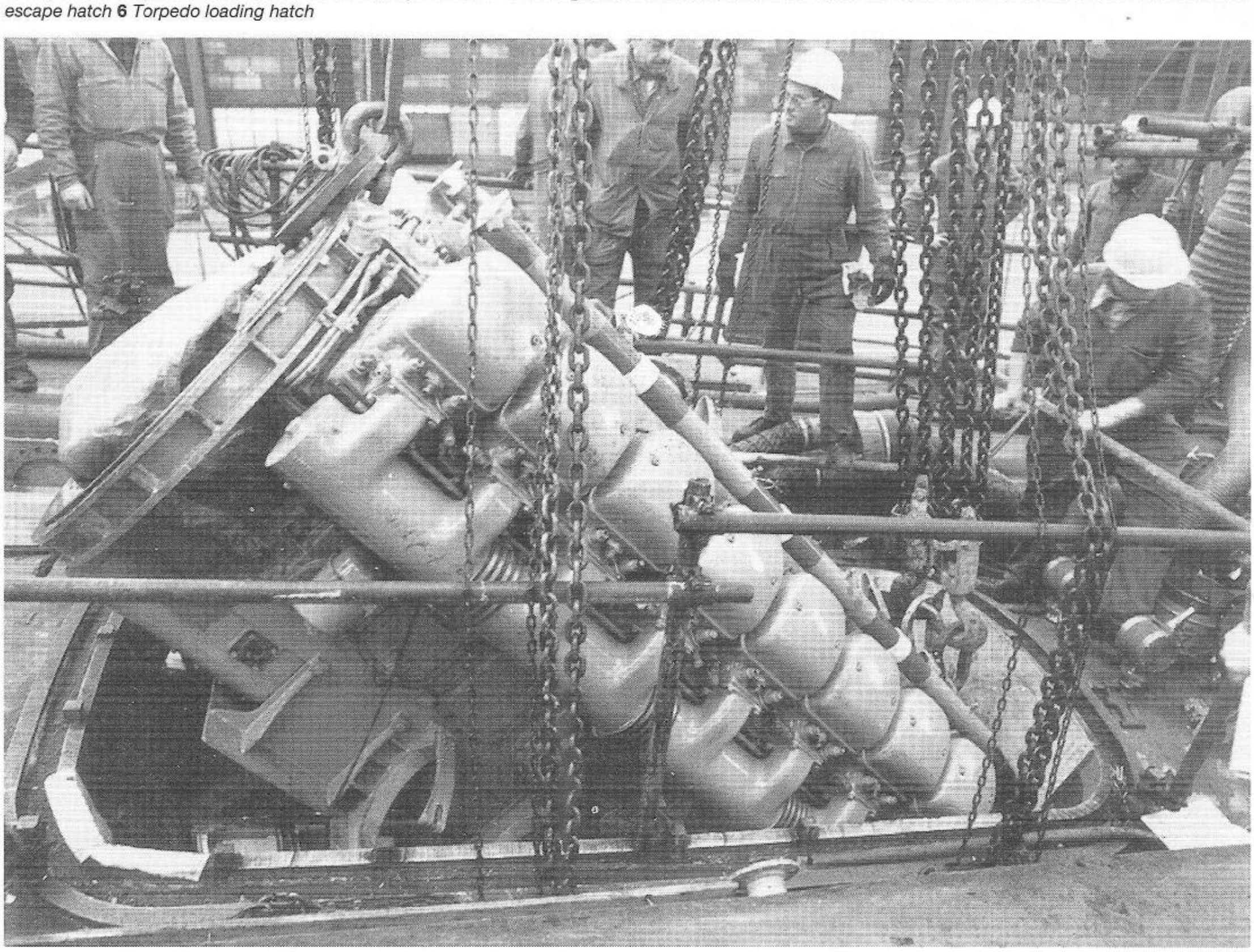


CUTAWAY: AGOSTA

1 *Creep electric motor* **2** *Main electric motor* **3** *Propulsion room* **4** *Diesel generator* **5** *Power compartment* **6** *Galley* **7** *Ventilation room* **8** *Auxiliary machinery room #1* **9** *Main crew accommodation* **10** *Battery compartment #1* **11** *Petty officers' accommodation* **12** *Officers' accommodation* **13** *Auxiliary machine room #2* **14** *Combat information centre/Control room* **15** *Battery compartment #2* **16** *Sail* **17** *Bridge* **18** *Access trunk* **19** *Forward crew accommodation/torpedo compartment* **20** *Torpedo tubes*



Hatches and hull openings (DCN)
1 *Propulsion compartment hull breach and aft escape hatch* **2** *Aft loading and access hatch* **3** *Snort air ventilation trunk* **4** *Main access trunk hatches* **5** *Forward escape hatch* **6** *Torpedo loading hatch*



Loading the starboard diesel generator through the propulsion compartment hull break (DCN)

AGOSTA, FRANCE

GENERAL SPECIFICATIONS

Country: France

Class: AGOSTA
Type: Sous-Marins d'Attaque (SSA)

Built: 4
In service: 4

Displacement:
surfaced: 1,230 t (standard)
submerged: 1,760 t

Dimensions
Length: 67.90 m (222.76 ft)
Beam: 6.80 m (22.31 ft)
Draught (aft): 5.12 m (16.8 ft)

Speed
surfaced: 12 kts
snorting: 10.5 kts
submerged: 20.5 kts (5 min); 17.5 kts (60 min)
transit (20% indiscretion ratio): 7 kts

Range:
submerged: 17.5 n miles at 17.7 kts; 178 n miles at 3.5 kts
snorting: 7,000 n miles at 10.5 kts
Diving depth: 300 m (984 ft)
Endurance: 45 days

Complement: 54 (7 officers)

SUBMARINES

AGOSTA (S 620)
Builder Naval Dockyard, Cherbourg, France
Laid down 1 Nov 1972
Launched 19 Oct 1974
Commissioned 28 Jul 1977

BEVEZIERS (S 621)
Builder Naval Dockyard, Cherbourg, France
Laid down 17 May 1973
Launched 14 Jun 1975
Commissioned 27 Sep 1977

LA PRAYA (S 622)
Builder Naval Dockyard, Cherbourg, France
Laid down 1974
Launched 15 May 1976
Commissioned 9 March 1978

OUESSANT (S 623)
Builder Naval Dockyard, Cherbourg, France
Laid down 1974
Launched 23 Oct 1976
Commissioned 27 July 1978

WEAPONS SYSTEMS

'Agosta' class torpedo launching system (DCN)

The launching system uses a fire-section telescopic pneumatic ram, which pushes the tail of the torpedo/missile over a distance of approximately 4 m. The tube comprises an annular section around the torpedo which allows seawater to enter through the tube's forward door, which enables the pressure to be balanced at the rear of the torpedo. Thus, ejection speed is almost independent of dive depth and the system allows torpedoes to be launched at any depth and any speed.

ANTI-SHIP MISSILES

Aerospatiale SM 39 Exocet
The SM 39 Exocet anti-ship missile is launched from 533 mm (21 in) torpedo tubes.

Specifications
Length: 5.21 m (17.09 ft)
Diameter: 35 cm (13.78 in)
Wing span: 1.00 m (3.28 ft)
Weight: 660 kg (1,455 lb)
Range: 2-27 n miles (4-50 km)
Speed: Mach 0.9
Guidance: Inertial and active radar
Warhead: 165 kg (364 lb)

Manufacturer/Contractor
Aerospatiale, Paris, France.

TUBES

Four 533 mm (21 in) torpedo tubes; bow.
Total weapon load, 20 (or mines in lieu), mixed according to the tactical situation.

Agosta *(S 620)* (H & L van Ginderen Collection)

TORPEDOES

L5 Mod 3 heavyweight, dual-purpose torpedo

L5 is a heavyweight ASW torpedo, which can be used for direct or indirect attacks. The weapon is of conventional design with blunt nose, four fins and twin contra-rotating propellers. The body is made of a light alloy and the nose of laminated material. All models are electrically propelled with silver-zinc batteries. They have passive/active seekers which have various operating modes including direct attack or programmed search. Mod 3 is the submarine-launched version.

Specifications
Length: 4.4 m (14.44 ft)
Diameter: 533 mm (21 in)
Weight: 1,300 kg (2,866 lb)
Range: 5.1 n miles (9.5 km)
Max speed: 35 kts
Warhead: 150 kg (331 lb)
Depth: To 550 m (1,800 ft)
Homing: Active/passive homing
Propulsion: Electric (silver/zinc batteries)

Manufacturer/Contractor
DCN International, Paris, France.

Operations centre in an 'Agosta' class submarine (Thomson-Marconi)

F17 Mod 2 heavyweight, dual-purpose torpedo

F17 is a submarine-launched heavyweight multirole weapon for use against surface and submarine targets and is compatible with pneumatic rammer, water pulse or swim-out launching systems. In the normal launch procedure, the torpedo is wire-guided during the early part of its run and is given commands on course and depth to be achieved at the end of the wire-guided operation from the submarine. During the terminal phase the torpedo uses passive search only throughout attacks against surface ships, but against submarine targets the passive mode is used until the terminal phase when the seeker goes active.

Specifications
Length: 5.4 m (17.7 ft)
Diameter: 533.4 mm
Weight: 1,406 kg (4,000 lb)
Range: 10.75 n miles (20 km)
Max speed: 28/40 kts
Warhead: 250 kg (551 lb) HBX3
Fuzes: Contact and magnetic
Depth: 6-20 m (20-66 ft) against surface ships; 30 m (98.5 ft), 100 m (328 ft), 200 m (656 ft) against submarines
Guidance: Wire and automatic passive/active homing
Propulsion: Electric (silver/zinc batteries)

Manufacturer/Contractor
DCN International, Paris, France.

MINES

FG 29 Mines

Up to 32 FG 29 mines can be carried in lieu of torpedoes. The FG 29 mine is laid from the submarine's torpedo tubes and has multi-influence detectors. It is fitted with an arming delay and an anti-sweep device, and is designed to resist explosion-based minesweeping methods.

Specifications
Length: 3 m (9.84 ft)
Diameter: 520 mm (20.4 in)
Weight: 1,000 kg (2,205 lb)
Explosive: 600 kg (1,323 lb)
Max depth: 300 m (984 ft)
Fuzing: Magnetic, acoustic, pressure

Manufacturers/Contractors
DCN, Paris, France (prime).
Thomson-Sintra, Paris, France (sensors).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thomson-CSF ARUR/ARUD

ARUR/ARUD is the French Navy's version of Thomson-CSF's DR 2000U ESM system. The system detects pulse and continuous wave (CW) signals, and when coupled with the Dalia analyser is used as a basic ESM suite, under the company designation TMV 434. There are six DF antennas and one omni-antenna on a telescopic mast, and a processing control/display console inside the submarine. It provides a virtual 100 per cent probability of detection over the complete 360° of azimuth and gives instantaneous audio and video alerts. DR 2000U Mk 3, installed in the Agostas, is an improved version with better sensitivity. The Dalia analyser provides alarm analysis and identification facilities through a library of 1000 radar modes and parameters and is easily reprogrammable.

Manufacturer/Contractor
Thomson-CSF, RCM, Elancourt, France.

La Praya *(S 622)* (H & L van Ginderen Collection)

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Thomson-CSF DLA 2A weapon control system

DLA (Direction de Lancement d'Armes) comprises a target data module and a weapon module. The target data module is built around a large cathode-ray tube (CRT) for the display of tactical data, which is based upon the Cimsa Sintra 15M125 processor, using the LTR software language. DLA accepts target data from sonar systems (bearing, range and Doppler), and uses them to compute the target parameters required by the weapon module. The weapon module computer accepts data on target bearing, range, course and speed, and processes this information to produce the necessary parameters for the sequencing, setting, and launching or firing of the weapon.

Manufacturer/Contractor
Thomson-CSF, RCM, Elancourt, France.

RADAR

Thomson-CSF DRUA-33C

DRUA-33 radar (also known as Calypso) carries out air-space and surface surveillance while the submarine is on the surface, and is also used for navigation. There is a single operating console below and the rotating antenna is positioned atop a mast to give maximum coverage. An earlier version, Calypso III, is quoted as being able to detect a 10 m² target, such as an ASW aircraft, at 18 n miles and a height of 2,500 m (8,200 ft).

Specifications
Role: Surveillance and navigation
Frequency bands: I/J
Pulse: 1 ms
Range: min 10 n miles
Peak output power: 25 kW

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

Ouessant *(S 623)* (H & L van Ginderen Collection)

SONARS

Thomson-CSF DUUA 2D

The DUUA 2D is an active search sonar located in the after edge of the sail. It operates as a searchlight at a frequency of 8 kHz at a maximum power of 30 kW. Narrowband receiver coverage is ±500 Hz around any selected frequency between 2 and 15 kHz while broadband coverage is between 2.5 and 15 kHz.

Thomson-CSF DUUX 2

DUUX-2 is a passive rangefinding system, with three transducers along each side of the submarine, with target direction being obtained by the phase difference between the signals received by the three transducers. Operating frequency is 5, 7, 12 and 18 kHz and range accuracy is of the order of 10 per cent at 30 km, 2.5 per cent at 10 km and 1 per cent at 5 km.

Thomson Sintra DSUV 22C

DSUV 22C is a passive hull array, cylindrical in shape, which is mounted in the lower forward part of the bows. It has 64 staves, producing 128 preformed beams, and giving 360° coverage. It operates at medium frequency.

Thomson-CSF DSUV 62A

DSUV 62A is a towed, passive, very low-frequency, sonar array, designed to enable submarines to track a contact and to provide data for the fire-control system.

Manufacturer/Contractor
Thomson-CSF, Paris, France.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 SEMT-Pielstick 16 PA4 V 185 VG supercharged diesels; 2.65 MW (3,600 hp(m))
Alternators: 2–1.7 MW

Electric motor: 1 motor; 3.75 MW (4,600 hp(m)) for 5 min or 2,200 kW (3,000 hp(m)) sustained
Creep motor: 1 electric motor; 23 kW (31 hp(m))
Shafts: 1

Propeller
Fuel tank capacity: 220 m³ (7,770 cu ft)
Battery: 2 groups, each of 160 cells

FURTHER INFORMATION

MODERNISATION

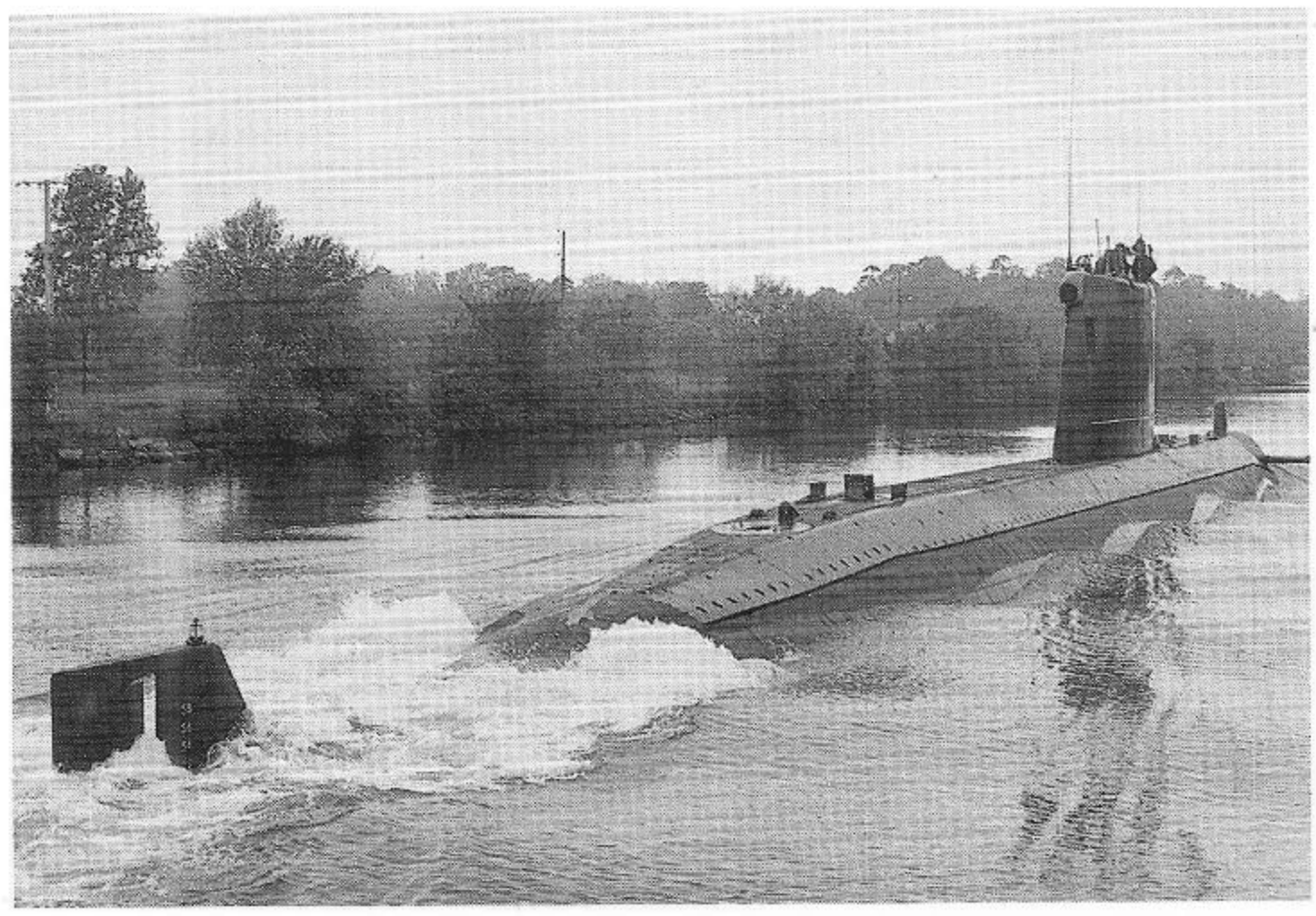
All four boats underwent a mid-life updating in the mid-1980s, the last being completed in 1987. This included fitting an improved torpedo discharge and reloading system and adapting the tubes and fire-control systems to enable SM 39 Exocet to be carried and launched. Many of the sonars and electronic equipments were also upgraded.

OPERATIONAL

All based at Brest by 1 July 1995 and operate principally in the Atlantic.

THE FUTURE

It has been the French Navy's intention for some time that this would be the last diesel-electric class, but under plans made in the late 1980s the first three boats were due to be retired in 2002, followed by the last, *Ouessant,* in 2003. Following President Chirac's major defence policy statement in January 1996, however, it appears that they will be retired earlier.



Beveziers *(S 621)* (H & L van Ginderen Collection)

AGOSTA, PAKISTAN

GENERAL SPECIFICATIONS

Country: Pakistan

Class: HASHMAT
Type: Agosta

Built: 2
In service: 2
Building: 3

Displacement:
surfaced: 1,490 t
submerged: 1,740 t
submerged (MESMA version): 1,960 t

Dimensions
Length: Agosta – 67.6 m (221.7 ft); Agosta 90B – 76.27 m (250.23 ft)
Beam: 6.8 m (22.3 ft)
Draught: 5.4 m (17.7 ft)

Speed
surfaced: 12 kts
submerged: 20 kts
Diving depth: Agosta – 300 m (985 ft); Agosta 90B – 350 m (1,150 ft)
Range:
snorting: 8,500 n miles at 9 kts
submerged: 350 n miles at 3.5 kts

Complement: Agosta – 54 (7 officers); Agosta 90B – 36

SUBMARINES

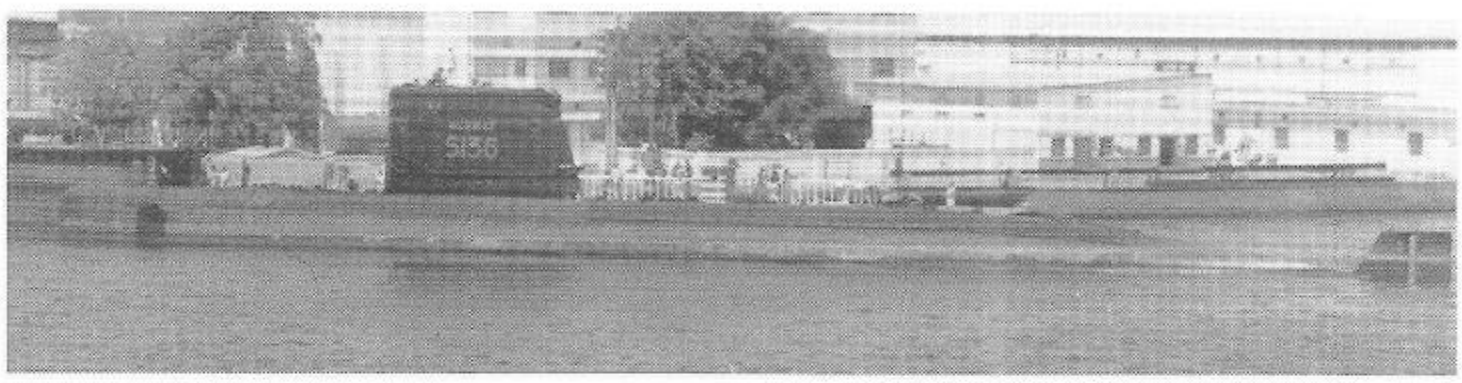
Agosta (first batch)

HASHMAT (S 135)

Builder	Dubigeon Normandie, Nantes, France
Laid down	15 Sep 1976
Launched	14 Dec 1977
Commissioned	17 Feb 1979

HURMAT (S 136)

Builder	Dubigeon Normandie, Nantes, France
Laid down	18 Sep 1977
Launched	1 Dec 1978
Commissioned	18 Feb 1980



Hurmat *(S 136) in 1994* (H & L van Ginderen Collection)

Agosta 90B (second batch)

(S 137)

Builder	DCN, Cherbourg, France
Laid down	1995
Launched	1997
Commissioned	1998-99

(S 138)

Builder	DCN, Cherbourg, France/Naval Dockyard, Karachi, Pakistan
Laid down	-
Launched	-
Commissioned	2002

(S 139)

Builder	Naval Dockyard, Karachi, Pakistan
Laid down	-
Launched	-
Commissioned	2004

WEAPONS SYSTEMS

ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Sub-Harpoon (S 135-136)

Both S 135 and S 136 have been adapted to carry and launch Sub-Harpoon. The Pakistan Navy is known to have a stock of these weapons, although whether they were obtained direct from the United States or indirectly though a third party is not clear, nor is it known to which production block they belong. Agosta 90Bs will have SM 39 Exocet.

Specifications
Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 kg)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Hurmat *(S 136) showing the after control surfaces and five-bladed propeller* (DCN)

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA. (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

Four 533 mm (21 in); pneumatic ram ejection.
Total weapon load, 20; mix of Sub-Harpoon/SM-39 Exocet.

TORPEDOES

Up to 20 ECAN F17P or AEG SUT; wire-guided; active/passive homing; water ram discharge gear.

F17P 2 heavyweight, dual-purpose torpedo

F 17P is a submarine-launched heavyweight multirole weapon for use against surface and submarine targets and is compatible with the pneumatic rammer used in the Pakistani submarines. In the normal launch

procedure, the torpedo is wire-guided during the early part of its run and is given commands on course and depth to be achieved at the end of the wire-guided operation from the submarine. During the terminal phase the torpedo uses passive search only throughout attacks against surface ships, but against submarine targets the passive mode is used until the terminal phase when the seeker goes active.

Specifications
Length: 5.914 m (19.4 ft)
Diameter: 533 mm (21 in)
Weight: 1,519 kg (3,349 lb)
Range: 9.98 n miles (18.5 km)
Max speed: 28/40 kts
Warhead: 250 kg (551 lb) HBX3
Fuzes: Contact and magnetic
Depth: 6-20 m (20-66 ft) against surface ships; max 500 m (1,640 ft) against submarines
Guidance: Wire and automatic passive/active homing
Propulsion: Electric (silver/zinc batteries)

Manufacturer/Contractor
DCN International, Paris, France.

MINES

GEC-Marconi Stonefish
The GEC-Marconi Stonefish can be carried in place of torpedoes.

Specifications
Mk II Warstock Mine
Length: 1,812 mm
Diameter: 533 mm
Weight: 770 kg
Warhead: 500 kg PBX

Manufacturer/Contractor
GEC-Marconi Naval Systems, Waterlooville, Hampshire, UK.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

ARUR/ARUD
ARUR/ARUD is the French Navy's version of Thomson-CSF's DR 2000U ESM system. The system detects pulse and continuous wave (CW) signals, and when coupled with the Dalia analyser is used as a basic ESM suite, under the company designation TMV 434. There are six DF antennas and one omni-antenna on a telescopic mast, and a processing control/display console inside the submarine. It provides a virtual 100 per cent probability of detection over the complete 360° of azimuth and gives instantaneous audio and video alerts. DR 2000U Mk 3, installed in the Agostas, is an improved version with better sensitivity. The Dalia analyser provides alarm analysis and identification facilities through a library of 1000 radar modes and parameters and is easily reprogrammable.

Manufacturer/Contractor
Thomson-CSF, RCM, Elancourt, France.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

SUBTICS
The Agosta 90B will have a new command system, designated SUBTICS, which is being developed and marketed by UDS International, a 50:50 subsidiary of DCN International and Thomson Sintra. It is built around software written by DCN and a Thomson Sintra sonar. It is a fully integrated combat system with improvements in terms of data processing, fire-control system and tactical display. Software is derived from the TITLAT (Traitement des Informations Tactiques = tactical data processing, tactical weapons fire-control) system, which was developed for the 'Le Triomphant' class SSBNs.

RADAR

Thomson-CSF DRUA-33
DRUA-33 radar (also known as Calypso) carries out airspace and surface surveillance while the submarine is on the surface, and is also used for navigation. There is a single operating console below and the rotating antenna is positioned atop a mast to give maximum coverage. An earlier version, Calypso III, is quoted as being able to detect a 10 m² target, such as an ASW aircraft, at 18 n miles and a height of 2,500 m (8,200 ft).

Specifications
Role: Surveillance and navigation
Frequency bands: I/J
Pulse: 1 ms
Range: min 10 n miles
Peak output power: 25 kW

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

SONARS

Thomson-CSF DUUA 1
DUUA 1 is an active/passive searchlight sonar, operating in six bands between 13.5 and 30 kHz in the active mode, and 1-40 kHz passive. Transducer scanning is either automatic or manual.

Manufacturer/Contractor
Thomson-CSF, RCM, Elancourt, France.

Thomson-CSF DUUA 2A/B
The DUUA 2D is an active search sonar located in the after edge of the sail. It operates as a searchlight at a frequency of 8 kHz at a maximum power of 30 kW. Narrowband receiver coverage is ±500 Hz around any selected frequency between 2 and 15 kHz while broadband coverage is between 2.5 and 15 kHz.

Manufacturer/Contractor
Thomson-CSF, RCM, Elancourt, France.

DSUV 2H
DSUV 2 is a passive array mounted in the lower part of the bow, originally fitted in the French 'Daphné' class.

Manufacturer/Contractor
Thomson-CSF, RCM, Elancourt, France.

DUUX 2
DUUX-2 is a passive rangefinding system, with three transducers along each side of the submarine, with target direction being obtained by the phase difference between the signals received by the three transducers. Operating frequency is 5, 7, 12 and 18 kHz and range accuracy is of the order of 10 per cent at 30 km, 2.5 per cent at 10 km and 1 per cent at 5 km.

Manufacturer/Contractor
Thomson-CSF, RCM, Elancourt, France.

PERISCOPES

The Agosta 90B will be fitted with a modernised SOPELEM periscope, with a DRM 3000 ESM antenna.

Manufacturer/Contractor
SOPELEM-Sofretec, Bezons, France.

PROPULSION

Specifications
System: Diesel-electric (see 'Further Information' below)
Main Machinery: 2 SEMT-Pielstick 16 PA4 V 185 VG diesels; 2.65 MW (3,600 hp(m))
Alernators: 2 Jeumont Schneider; 1.7 MW
Electric motor: 1—3.4 MW (4,600 hp(m))
Creep motor: 1—23 kW (32 hp(m))
Shaft: 1
Battery: 2 groups each of 160 cells

FURTHER INFORMATION

PROGRAMME

The first two of these 'Agosta' class submarines were originally ordered in 1975 by the Republic of South Africa Navy, where they would have been named Astrant and Adventurous. The French Government was, however, forced to cancel the order in 1978 in order to comply with the United Nations embargo on arms sales to South Africa, by which time the first had been launched and was fitting out, and the second was within months of being launched. Pakistan, however, which already operated four 'Daphné' class boats (see 'Hangor' class below) was able to snap up the two boats, as a result of which *Hashmat* arrived in Karachi on 31 October 1979 and *Hurmat* on 11 August 1980.

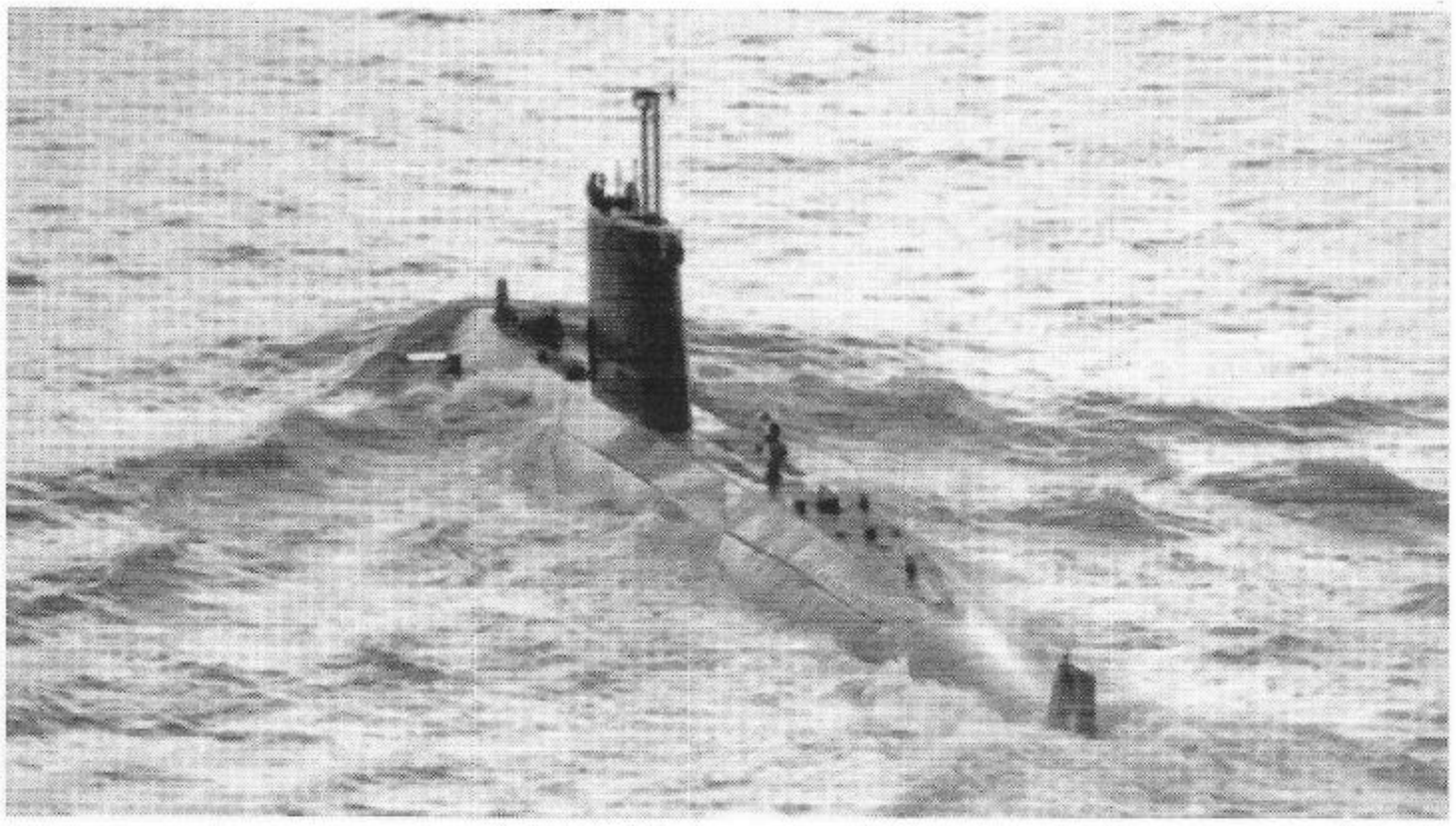
Some 12 years later a provisional order for a second batch of three more of the class was reported in September 1992, which was confirmed on 21 September 1994. Pakistan had been looking for new submarines for some time and was known to have been offered several other designs, including the T-96 by Sweden, the redundant 'Upholder' class by the UK and the modified Romeo (possibly the 'Ming' class) by China.

The plan is that the first Agosta 90B will be built in France, the second will be built in sections in France and then transferred to Pakistan for final assembly and the third will be completely built in Pakistan. The programme will span 10 years.

DESIGN

The first two boats as built were virtually identical with the French Agostas, but were modified in 1984-85 to launch Sub-Harpoon anti-ship missiles.

Although nominally to the same design, the new boats will obviously have updated equipment to take account of technological developments since the last of the first batch of Agostas was launched; they are officially designated Agosta 90B.



Hurmat *(S 136) on sea trials* (DCN)

The Agosta 90B will feature improved silencing, the new SUBTICS command system (described above) and greatly increased automation, which will reduce total crew numbers from 54 to 36. The original Agostas were constructed of HLES 60 steel (that is, it offers a resistance of 60 kg in every direction per square millimetre) but the new boats will be constructed of HLES 80 steel (the same as that used in the 'Améthyste' class SSNs), making possible a greater diving depth of some 350 m (1,150 ft). The Pakistan Navy also hopes to obtain SM 39 Exocet missiles, which are the subject of separate negotiations with Dassault.

The most unusual part of the deal, however, is that it is planned that the third boat will have a MESMA liquid oxygen AIP system, which would require a plug to be inserted in the hull; the plug displaces 220 t and is 8.67 m (28.44 ft) long. A shore-based prototype is being built at DCN Indret and the first operational system will be installed directly into the third hull; that is, the first hull to be completely constructed in Pakistan. The Pakistan Navy and its dockyard organisation are certainly very experienced in operating and supporting submarines, but other submarine construction programmes (for example, in Argentina, Brazil and India) have shown that such first builds in new yards are already difficult enough, without adding a new factor such as an AIP system. Having said that, however, Australia and Turkey have both set up submarine construction yards with little apparent difficulty.

AGOSTA, SPAIN

GENERAL SPECIFICATIONS

Country: Spain

Class: GALERNA
Type: Agosta

Built: 4
In service: 4

Displacement:
surfaced: 1,490 t
submerged: 1,740 t

Dimensions
Length: 67.6 m (221.7 ft)
Beam: 6.8 m (22.3 ft)
Draught: 5.4 m (17.7 ft)

Speed:
surfaced: 12 kts
submerged: 20 kts max; 17.5 kts sustained
Diving depth: 300 m (984 ft)

Range:
snorting: 8,500 n miles
dived (using 'creep' motor): 350 n miles at 3.5 kts
Endurance: 45 days

Complement: 54 (6 officers)

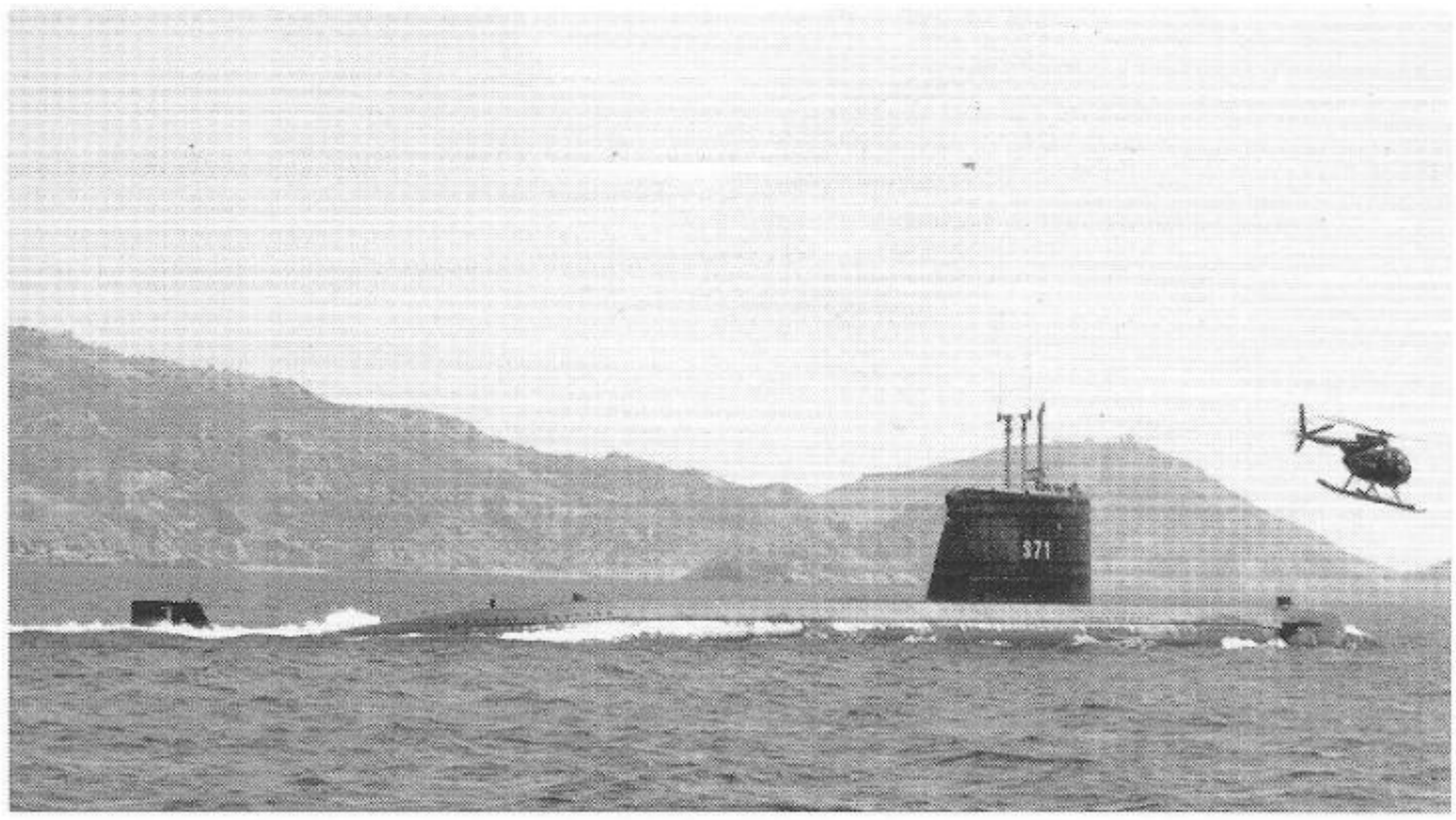
SUBMARINES

GALERNA (S 71)
Builder Bazán, Cartagena, Spain
Laid down 5 Sep 1977
Launched 5 Dec 1981
Commissioned 22 Jan 1983

SIROCO (S 72)
Builder Bazán, Cartagena, Spain
Laid down 27 Nov 1978
Launched 13 Nov 1982
Commissioned 5 Dec 1983

MISTRAL (S 73)
Builder Bazán, Cartagena, Spain
Laid down 30 May 1980
Launched 14 Nov 1983
Commissioned 5 Jun 1985

TRAMONTANA (S 74)
Builder Bazán, Cartagena, Spain
Laid down 10 Dec 1981
Launched 30 Nov 1984
Commissioned 27 Jan 1986



Spanish submarine Galerna *(S 71) of the French Agosta design* (E N Bazán)

WEAPONS SYSTEMS

TUBES

Four 533 mm (21 in) tubes.
Total weapons carried, 20; combination of ECAN L5 and ECAN F17.

TORPEDOES

L5 Mod 3/4 heavyweight, dual-purpose torpedo

L5 is a heavyweight ASW torpedo, which can be used for direct or indirect attacks. The weapon is of conventional design with blunt nose, four fins and twin contra-rotating propellers. The body is made of a light alloy and the nose of laminated material. All models are electrically propelled with silver-zinc batteries. They have passive/active seekers which have various operating modes including direct attack or programmed search. Mod 3 is the submarine-launched version.

Specifications
Length: 4.4 m (14.44 ft)
Diameter: 533 mm (21 in)
Weight: 1,300 kg (2,866 lb)
Range: 5.1 n miles (9.5 km)
Max speed: 35 kts
Warhead: 150 kg (331 lb)
Depth: To 550 m (1,800 ft)
Homing: Active/passive homing
Propulsion: Electric (silver/zinc batteries)

Manufacturer/Contractor
DCN International, Paris, France.

F 17 Mod 2 heavyweight, dual-purpose torpedo

F 17 is a submarine-launched heavyweight multirole weapon for use against surface and submarine targets and is compatible with pneumatic rammer, water pulse or swim-out launching systems. In the normal launch procedure, the torpedo is wire-guided during the early part of its run and is given commands on course and depth to be achieved at the end of the wire-guided operation from the submarine. During the terminal phase the torpedo uses passive search only throughout attacks against surface ships, but against submarine targets the passive mode is used until the terminal phase when the seeker goes active.

Specifications
Length: 5.4 m (17.7 ft)
Diameter: 533.4 mm
Weight: 1,406 kg (4,000 lb)
Range: 10.75 n miles (20 km)
Max speed: 28/40 kts
Warhead: 250 kg (551 lb) HBX3
Fuzes: Contact and magnetic
Depth: 6-20 m (20-66 ft) against surface ships; 30 m (98.5 ft), 100 m (328 ft), 200 m (656 ft) against submarines
Guidance: Wire and automatic passive/active homing
Propulsion: Electric (silver/zinc batteries)

Manufacturer/Contractor
DCN International, Paris, France.

MINES

19 mines can be carried if the torpedo load is reduced to 9.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thorn-EMI/Inisel Manta

Manta is an advanced submarine ESM system which intercepts, analyses, classifies and identifies enemy radars at long range in the 2 to 18 GHz range. In addition, Manta provides information for tactical battle management, targeting and information gathering. Instantaneous warning enables the submarine commander to maintain a covert posture. Manta uses wide open ESM techniques, providing 360° coverage and 100 per cent probability of intercept. Intercepted signals are automatically analysed and identified by reference to a comprehensive library of known radar types.

Specifications
Frequency range: 2-18 GHz
Bearing accuracy: 6-10° (2° optional)
Sensitivity: −40 dBm
Dynamic range: 40-50 dB
Track capacity: 255 emitters simultaneously

Manufacturers/Contractors
THORN EMI Electronics Ltd, Sensors Group, Crawley, UK.
Inisel, Madrid, Spain.

COMMAND AND CONTROL SYSTEMS

RADAR

Thomson-CSF DRUA-33C

DRUA-33 radar (also known as Calypso) carries out airspace and surface surveillance while the submarine is on the surface, and is also used for navigation. There is a single operating console below and the rotating antenna is positioned atop a mast to give maximum coverage. An earlier version, Calypso III, is quoted as being able to detect a 10 m^2 target, such as an ASW aircraft, at 18 n miles and a height of 2,500 m (8,200 ft).

Specifications
Role: Surveillance and navigation
Frequency bands: I/J
Pulse: 1 ms
Range: min 10 n miles
Peak output power: 25 kW

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

SONARS

Thomson Sintra DSUV 22C

DSUV 22C is a passive hull array, cylindrical in shape, which is mounted in the lower forward part of the bows. It has 64 staves, producing 128 preformed beams, and giving 360° coverage. It operates at medium frequency.

Manufacturer/Contractor
Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, France.

Thomson-CSF DUUA 2A

The DUUA 2A is an active search sonar located in the after edge of the sail. It operates as a searchlight at a frequency of 8 kHz at a maximum power of 30 kW. Narrowband receiver coverage is ±500 Hz at 8 or 8.4 kHz.

Manufacturer/Contractor
Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, France.

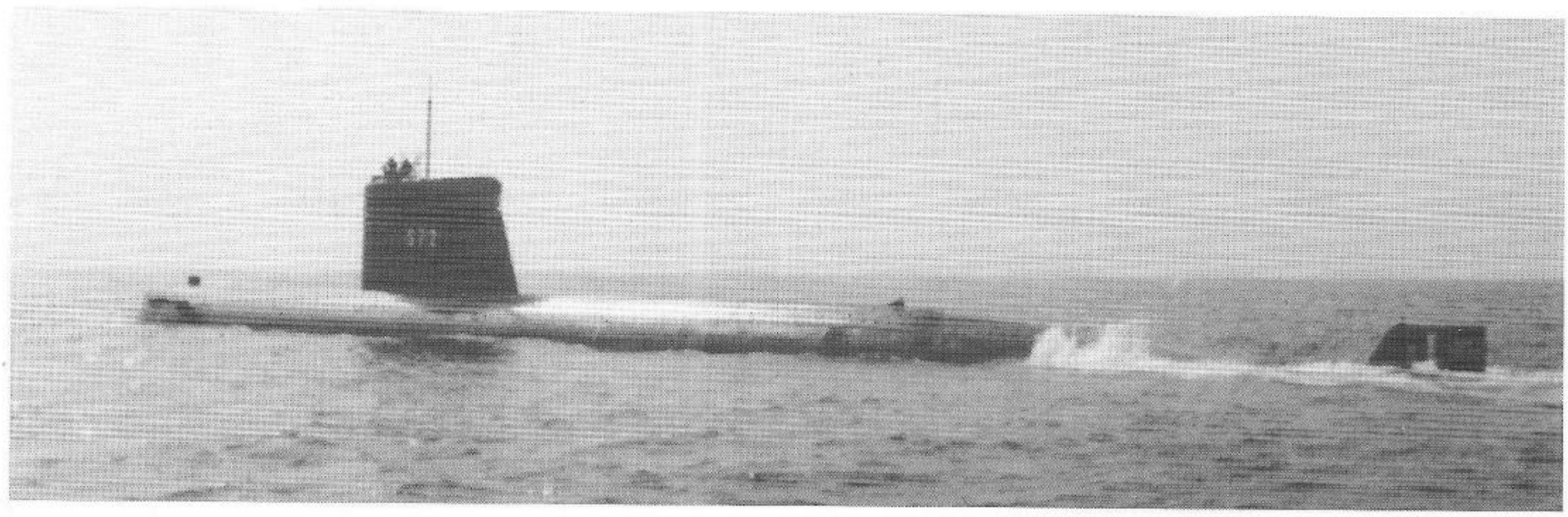
Thomson-CSF DUUX 2A (S 71-72)

DUUX-2A is a passive rangefinding system, with three transducers along each side of the submarine, with target direction being obtained by the phase difference between the signals received by the three transducers. Operating frequency is 5, 7, 12 and 18 kHz and range accuracy is of the order of 10 per cent at 30 km, 2.5 per cent at 10 km and 1 per cent at 5 km.

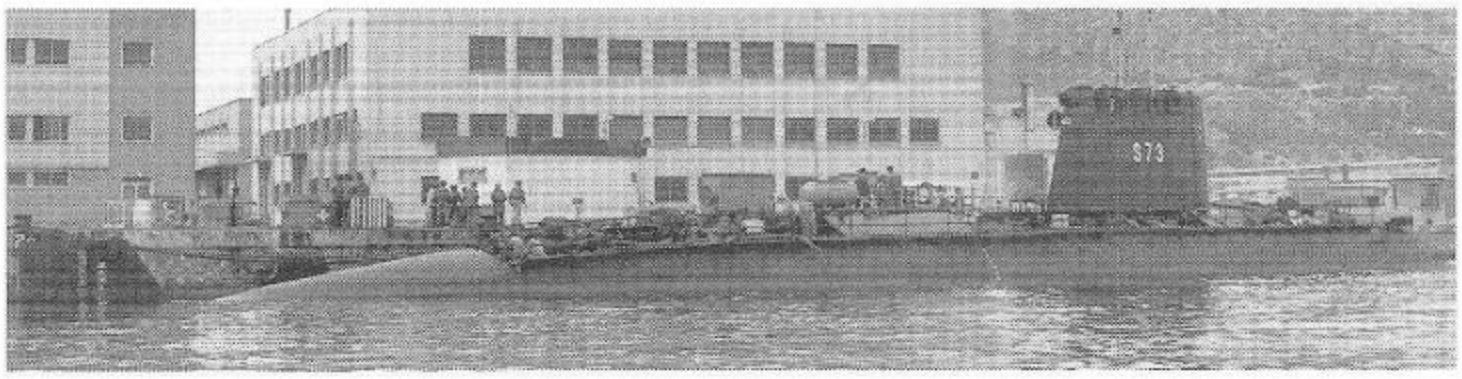
Manufacturer/Contractor
Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, France.

Thomson-Sintra DUUX-5 Fenelon (S 73-74)

DUUX-5 panoramic sonar is fitted in S 73 and S 74, which can track four targets simultaneously. It incorporates a passive acoustic rangefinder for measuring the range of three targets within 120° sectors, and a panoramic sonar interceptor measuring the true bearing of all sonar transmissions received in the 2-15 kHz band. Four targets can be tracked simultaneously (three on



Siroco *(S 72)* (E N Bazán)



Mistral *(S 73)* (H & L van Ginderen Collection)

radiated self-noise, one on sonar pulses), and there is a continuous panoramic bearing display over 360°. Target data is automatically transmitted to the ship's weapon control system and plotting table. Under normal conditions, results in the middle sector are 0.3° for bearing accuracy, 2° discrimination accuracy between two targets and 5 per cent of range on radiated noise for a target at 10 km distance. The hydrophonic unit is composed of two bases with three hydrophones each on the starboard and port sides of the submarine. All other technical details remain classified.

Manufacturer/Contractor

Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, France.

DSUV 62A

DSUV 62A is fitted in S 72-73 only. This is a towed, passive, very low-frequency, sonar array, designed to enable submarines to track a contact and to provide data for the fire-control system.

Manufacturer/Contractor

Thomson-CSF, Paris, France.

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 2 SEMT-Pielstick 16 PA4 V 185 VG diesels; 2.7 MW (3,600 hp(m))
Alternators: 2 Jeumont Schneider; 1.7 MW
Electric motor: 1—3.4 MW (4600 hp(m))
Creep motor: 1—23 kW (32 hp(m))
Shaft: 1
Battery: 2 batteries, each of 160 cells

FURTHER INFORMATION

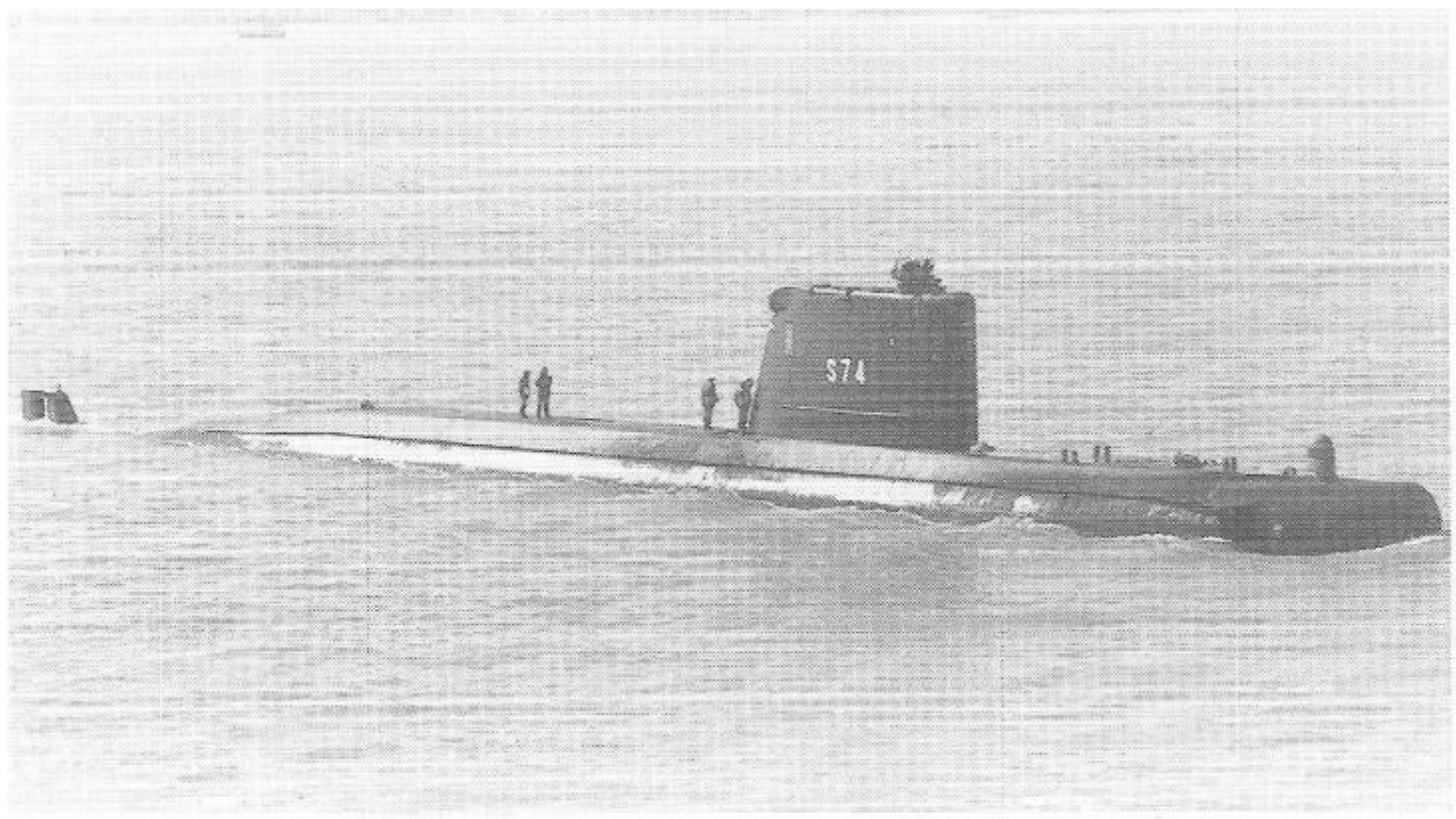
PROGRAMME

Following construction of the French 'Daphné' class (see 'Delfin' class entry below) the Spanish Navy decided to build four more French-designed submarines, this time the somewhat larger 'Agosta' class.

The first two were ordered on 9 May 1975, followed by the second pair on 29 June 1977 and they were built by Bazán at Cartagena, with some French advice. They are, in general, identical with the French-built boats, although about 67 per cent of equipment and structure is from Spanish sources.

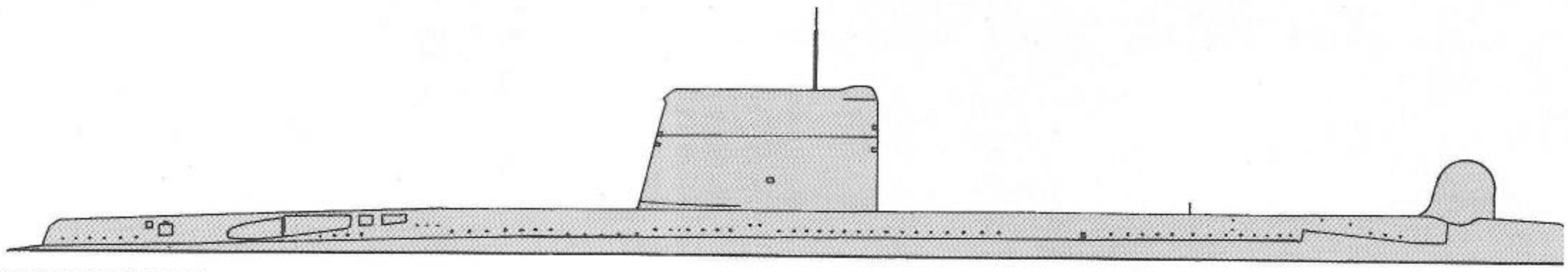
MODERNISATION

It is planned that all four will be modernised. This will involve fitting improved torpedo fire control, towed array sonars, new ESM equipment and infra-red enhanced periscopes. New main batteries will also be installed, together with central control monitoring. *Galerna* started its refit in April 1993 and completed in late 1994, when *Siroco* started. The programme has been slowed down by lack of funds and the plan to fit SSM has been shelved.



Tramontana *(S 74)* (H & L van Ginderen Collection)

DAPHNE CLASS



Daphne (Ian Sturton)

OVERVIEW

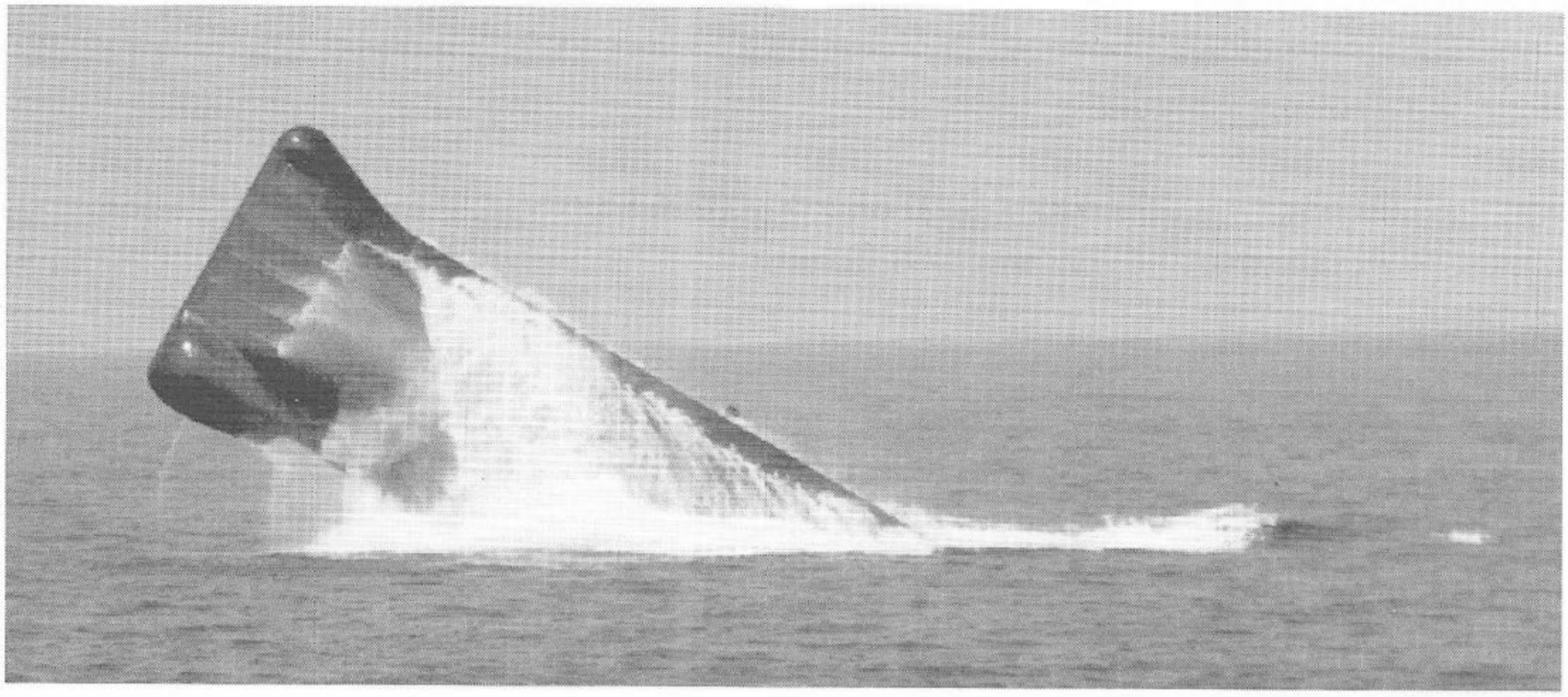
Barracuda *(S 164) of the Portuguese Navy* (Portuguese Navy)

In the early post-war years the French Navy found itself operating no less than fourteen types of submarine ranging in size from ocean-going types to midgets. One of these was the ex-German Type XXI U-2518, which was incorporated into the French Navy in 1945 as *Roland Morillot* (S 613). An improved version of the design was produced in France as the 'Narvhal' class: six were built in the 1960s, and were stricken between 1985 and 1992. Next came the smaller hunter-killer 'Arethuse' class, of which four were built between 1955 and 1958.

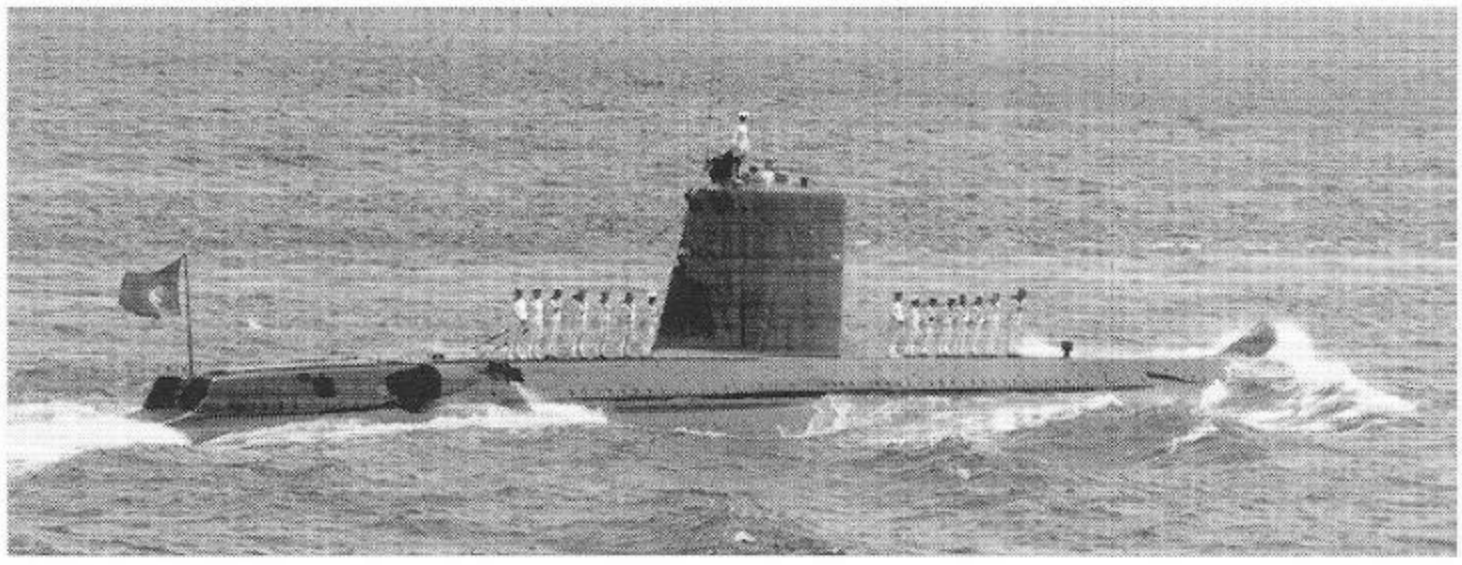
The 'Daphné' class is an enlarged version of the 'Arethuse' class, which was an immediate success and eleven were built for the French Navy between 1964 and 1970. The first boat to be stricken went in 1989 and there were only three left in 1996, with last due to go by 1999.

There was some alarm over the class when *Minerve* disappeared without trace in the Mediterranean in

Country	Class Name	Built/Purchased	Commissioned	In service (January 1997)	Remarks
France	Daphné	11	1964-70	2	2 lost at sea
Pakistan	Hangor	3 +1	1969-70	4	One bought from Portugal (1975)
Portugal	Albacora	4 –1	1967-69	3	One sold to Pakistan (1975)
South Africa	van Riebeeck	3	1970-71	3	
Spain	Delfin	4	1973-75	4	Built in Spain
Totals		26		16	



This dramatic shot clearly shows the four port torpedo tubes. The 'Daphné' class has eight bow tubes, with no reloads (Portuguese Navy)



Portugal's Delfin *(S 166) shows the four stern torpedo tubes; two are beneath the ensign firing directly astern and two further forward and angled outwards. All are in the outer casing and there are no reloads* (H & L van Ginderen Collection)

1968, followed, in equally mysterious circumstances, by *Euridyce* in 1970. These two tragic losses were very nearly followed by a third boat in 1971 when *Flore*'s schnorchel sprang a leak due to a faulty valve. On this occasion, however, the captain was able to take immediate remedial action and he saved his boat; there have been no more losses.

A further ten were built in French yards for foreign navies, while four were built by Bazán, Cartagena for the Spanish Navy.

One of the unusual features of the Daphné design is that, although there is a large number of torpedo tubes — 12 — there are no reloads. There are eight tubes in the bows, mounted in two vertical rows of four. The stern tubes are all in the outer casing, outside the pressure hull, with two right aft, launching over the propeller and two further forward and angled outwards at about 20°.

DAPHNE, FRANCE

GENERAL SPECIFICATIONS

Country: France

Class: DAPHNE

Built: 11
In service: 2

Displacement:
surfaced: 860 t
submerged: 1,038 t

Dimensions
Length: 57.8 m (189.6 ft)
Beam: 6.8 m (22.3 ft)
Draught: 4.6 m (15.1 ft)

Speed:
surfaced: 13.5 kts
submerged: 16 kts

Range:
surfaced: 2,700 n miles at 12.5 kts; 10,000 n miles at 7 kts
snorting: 4,500 n miles at 5 kts; 3,000 n miles at 7 kts
Diving depth:
operational: 300 m (984 ft)
crush: 575 m (1,886 ft)

Complement: 53 (7 officers)

SUBMARINES

PSYCHE (S 650)

Builder	Naval Dockyard, Brest, France
Laid down	May 1965
Launched	28 Jun 1967
Commissioned	1 Jul 1969

SIRENE (S 651)

Builder	Naval Dockyard, Brest, France
Laid down	May 1965
Launched	28 Jun 1967
Commissioned	1 Mar 1970

WEAPONS SYSTEMS

TUBES

12–550 mm (21.7 in); eight bow, four stern.
Total weapon load, 12.

TORPEDOES

ECAN E12

Originally developed by CIT-Alcatel, the E12 550 mm torpedo now remains in service in the French Navy only with these last of the 'Daphné' class. E12 can be used to attack surface vessels proceeding at speeds up to 20 knots and submarines at shallow (that is, periscope) depth. All E12s have been upgraded to Mod 2 standard with new silver/zinc (Ag/Zn) primary batteries.

Specifications
E12 Mod 2
Length: 7.0 m (22.96 ft)
Diameter: 550 mm (21.6 in)
Weight: 1,650 kg (3,638 lb)
Warhead: 300 kg (661 lb) Tolite A1
Propulsion: Electric; silver-zinc battery
Speed: 31 kts
Range: 6.6 n miles (12 km) at 25 kts
Detection range: 2,000 m (2,187 yd)
Search depth: 25 m (82 ft)
Attack depth: 6-18 m (20-60 ft) presettable
Max depth rating: 300 m (984 ft)
Guidance: Passive homing, medium range
Fuze: Impact/magnetic

Manufacturer/Contractor
Direction des Constructions Navales (DCN), Saint Tropez, France.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

DLT D3 torpedo control

The DLT-D3 torpedo fire-control system can launch all types of torpedo employed by the French Navy, including wire-guided, and can be expanded for anti-surface missile applications. Target data are fed to the system from onboard sensors (sonars, acoustic rangefinder and periscopes) and employs a CIMSA 15M125 general purpose digital computer, associated with a CRT display terminal. DLT-D3 operating programs permit tracking eight targets, simultaneous guidance of two wire-guided torpedoes and preparation for the launch of a third. Emergency launch of torpedoes is possible from either bow or stern station. DLT-D3 is served by one or two operators at the operations centre, a third operator at the bow station with possibly a fourth at the stern station.

Manufacturer/Contractor
Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex.

RADAR

Thomson-CSF DRUA-33

DRUA-33 radar (also known as Calypso) carries out airspace and surface surveillance while the submarine is on the surface, and is also used for navigation. There is a single operating console below and the rotating antenna is positioned atop a mast to give maximum coverage. An earlier version, Calypso III, is quoted as being able to detect a 10 m^2 target, such as an ASW aircraft, at 18 n miles and a height of 2,500 m (8,200 ft)

Specifications
Role: Surveillance and navigation
Frequency bands: I/J
Pulse: 1 ms
Range: min 10 n miles
Peak output power: 25 kW

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

SONARS

Thomson-CSF DSUV-2

DSUV-2 is a passive, medium-frequency sonar array mounted in the lower part of the bow.

Thomson-CSF DUUX 2

DUUX-2 is a passive rangefinding system, with three transducers along each side of the submarine. Target direction is obtained from the phase difference between the signals received by the three transducers. Operating frequency is 5, 7, 12 and 18 kHz and range accuracy is of the order of 10 per cent at 30 km, 2.5 per cent at 10 km and 1 per cent at 5 km.

Thomson-CSF DUUA 2D

The DUUA 2D is an active search sonar located in the after edge of the sail. It operates as a searchlight at a frequency of 8 kHz at a maximum power of 30 kW. Narrowband receiver coverage is ±500 Hz around any selected frequency between 2 and 15 kHz while broadband coverage is between 2.5 and 15 kHz.

PROPULSION

Specifications

System: Diesel-electric

Main Machinery:

S 643, S 648: 2 SEMT-Pielstick 12 PA1 diesels; 1.8 MW (2,450 hp(m))

S 650, S 651: 2 SEMT-Pielstick 12 PA4 V 185 diesels; 1.8 MW (2,450 hp)(m)

Alternators: 2 Jeumont Schneider; 900 kW

Electric motors: 2–1.9 MW (2,600 hp(m))

Shafts: 2

FURTHER INFORMATION

MODERNISATION

The whole class was modernised between 1971 and 1981. Two of the three surviving boats are now being given one more refit to enable them to serve into the new century: *Psyché* completed a refit in 1996 and will pay off in 2001; *Sirene* is being refitted in 1997 and will pay off in 2002. The third boat, *Junon*, was deleted at the end of 1996.

DEPLOYMENT

Psyche and *Sirene* are based at Lorient.

French Navy 'Daphne' class submarine Junon *(S 648)* (G Gyssels)

DAPHNE, PAKISTAN

GENERAL SPECIFICATION

Country: Pakistan

Class: HANGOR
Type: Daphné

Bought: 4
In service: 4

Displacement:
surfaced: 869 t
submerged: 1,043 t

Dimensions
Length: 57.8 m (189.6 ft)
Beam: 6.8 m (22.3 ft)
Draught: 4.6 m (15.1 ft)

Speed
surfaced: 13 kts
submerged: 15.5 kts
Diving depth: 300 m (985 ft)

Range:
surfaced: 2,700 n miles at 12.5 kts; 10,000 n miles at 7 kts
snorting: 4,500 n miles at 5 kts; 3,000 n miles at 7 kts

Complement: 45 (5 officers)

SUBMARINES

HANGOR (S 131)
Builder Arsenal de Brest, Brest, France
Laid down 1 Dec 1967
Launched 28 Jun 1969
Commissioned 12 Jan 1970

SHUSHUK (S 132)
Builder CN Ciotat, Le Trait, France
Laid down 1 Dec 1967
Launched 30 July 1969
Commissioned 12 Jan 1970

MANGRO (S 133)
Builder CN Ciotat, Le Trait, France
Laid down 8 Jul 1968
Launched 7 Feb 1970
Commissioned 8 Aug 1970

GHAZI (S 134) (ex-Portuguese Cachalote)
Builder Dubigeon Normandie, Nantes, France
Laid down 12 May 1967
Launched 23 Sep 1968
Commissioned Portuguese Navy — 1 Oct 1969
Commissioned Pakistani Navy — Dec 1975

WEAPONS SYSTEMS

ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Sub-Harpoon (S 135-136)

All four 'Hangor' class boats have been adapted to carry and launch Sub-Harpoon. The Pakistan Navy is known to have a stock of these weapons, although whether they were obtained direct from the United States or indirectly though a third party is not clear, nor is it known to which production block they belong.

Specifications

Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

12–550 mm (21.7 in); eight bow, four stern.
Total weapon load, 12.

TORPEDOES

L5 Mod 3 heavyweight, dual-purpose torpedo

L5 is a heavyweight ASW torpedo, which can be used for direct or indirect attacks. The weapon is of conventional design with blunt nose, four fins and twin contra-rotating propellers. The body is made of a light alloy and the nose of laminated material. All models are electrically propelled with silver/zinc batteries. They have passive/active seekers which have various operating modes including direct attack or programmed search. Mod 3 is the submarine-launched version.

Specifications

Length: 4.4 m (14.44 ft)
Diameter: 533 mm (21 in)
Weight: 1,300 kg (2,866 lb)
Range: 5.1 n miles (9.5 km)
Max speed: 35 kts
Warhead: 150 kg (331 lb)
Depth: To 550 m (1,800 ft)
Homing: Active/passive homing
Propulsion: Electric (silver/zinc batteries)

Manufacturer/Contractor

DCN International, Paris, France.

AEG SUT

SUT (Surface and Underwater Target) is a dual-purpose, wire-guided torpedo for engaging both surface and submarine targets. Its electrical propulsion permits variable speed in accordance with tactical requirements, silent running and wakelessness. The wire guidance gives immunity to interference with a two-way datalink between vessel and torpedo. The acoustic homing head has long acquisition ranges and a wide search sector for active and passive operation. After termination of guidance wire, SUT continues operation as a highly intelligent homing torpedo, with internal guidance programmes for target search, target loss and so on. The large payload with combined fuze systems ensures the optimum effect of explosive power. The SUT operates at great depths as well as in very shallow waters. Consort operation permits exploitation of the full over-the-horizon range of the SUT.

Specifications

Length: 6,150 mm (20.18 ft)
Diameter: 533 mm (21 in)
Weight: 1,420 kg (3,130 lb)
Warhead: 260 kg (573 lb)
Speed: Selectable, max 35 kts
Range: >30 km
Fuze: Magnetic proximity and impact

Manufacturer/Contractor

STN Atlas Elektronik GmbH, Bremen, Germany.

MINES

GEC-Marconi Stonefish

The GEC-Marconi Stonefish can be carried in place of torpedoes.

Specifications

Mk II Warstock Mine
Length: 1,812 mm (5.9 ft)
Diameter: 533 mm (21 in)
Weight: 770 kg (1,698 lb)
Warhead: 500 kg PBX (1,102 lb)

Manufacturer/Contractor

GEC-Marconi Naval Systems, Waterlooville, Hampshire, UK.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

ARUR/ARUD

ARUR/ARUD is the French Navy's version of Thomson-CSF's DR 2000U ESM system. The system detects pulse and continuous wave (CW) signals, and when coupled with the Dalia analyser is used as a basic ESM suite, under the company designation TMV 434. There are six DF antennas and one omni-antenna on a telescopic mast, and a processing control/display console inside the submarine. It provides a virtual 100 per cent probability of detection over the complete 360° of azimuth and gives instantaneous audio and video alerts. DR 2000U Mk 3, installed in the Agostas, is an improved version with better sensitivity. The Dalia analyser provides alarm analysis and identification facilities through a library of 1000 radar modes and parameters and is easily reprogrammable.

Manufacturer/Contractor

Thomson-CSF, RCM, Elancourt, France.

COMMAND AND CONTROL SYSTEMS

RADARS

Thomson-CSF DRUA 31

DRUA 31 is an I-band surface search and navigation radar.

Manufacturer/Contractor

Thomson-CSF, RCM, Elancourt, France.

SONARS

Thomson-CSF DSUV 1

DSUV 1 is a rather elderly, hull-mounted, passive search sonar, operating at medium frequencies.

Manufacturer/Contractor

Thomson-CSF, RCM, Elancourt, France.

Thomson-CSF DUUA 1

DUUA 1 is an active/passive searchlight sonar, operating in six bands between 13.5 and 30 kHz in the active mode, and 1-40 kHz passive. Transducer scanning is either automatic or manual.

Manufacturer/Contractor

Thomson-CSF, RCM, Elancourt, France.

PROPULSION

Specifications
System: Diesel-electric
Main engines: 2 SEMT-Pielstick 12 PA4 V 185 diesels; 1.8 MW (2,450 hp(m))

Alternators: 2 Jeumont Schneider alternators; 1.7 MW
Electric motors: 2 motors; 1.9 MW (2,600 hp(m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

S 132, S 133 and S 134 were built in France for the Pakistani Navy, but S 135 was originally part of the order for the Portuguese Navy as *Cachalote,* and was not sold to Pakistan until December 1975. They are broadly similar to the other 'Daphné' class boats built in France and Spain, but are slightly modified internally to suit Pakistan's requirements and naval conditions. The SSM capability was added in late 1980s and these are the only 'Daphné' class boats capable of launching Sub-Harpoon.

OPERATIONAL

Hangor (S 131) was the first submarine to sink a surface warship since the end of the Second World War when it sank the Indian 'Blackwood' class frigate INS *Khukri* (F 49) on 9 December 1971, with 191 of the 288-man crew being lost. *Hangor* was in collision in September 1990 and badly damaged, but was repaired and returned to service in 1992.

DAPHNE, PORTUGAL

GENERAL SPECIFICATIONS

Country: Portugal

Class: ALBACORA
Type: Daphné

Built/Purchased: 4
Sold: 1
In service: 3

Displacement:
surfaced: 869 t
submerged: 1,043 t

Dimensions
Length: 57.8 m (189.6 ft)
Beam: 6.8 m (22.3 ft)
Draught: 5.2 m (17.1 ft)

Speed:
surfaced: 13.5 kts
submerged: 16
Diving depth:
operational: 300 m (984 ft)
crush: 575 m (1,885 ft)

Range:
surfaced: 2,700 n miles at 12.5 kts; 10,000 n miles at 7 kts
snorting: 4,500 n miles at 5 kts; 3,000 n miles at 7 kts

Complement: 55 (8 officers)

SUBMARINES

ALBACORA (S 163)

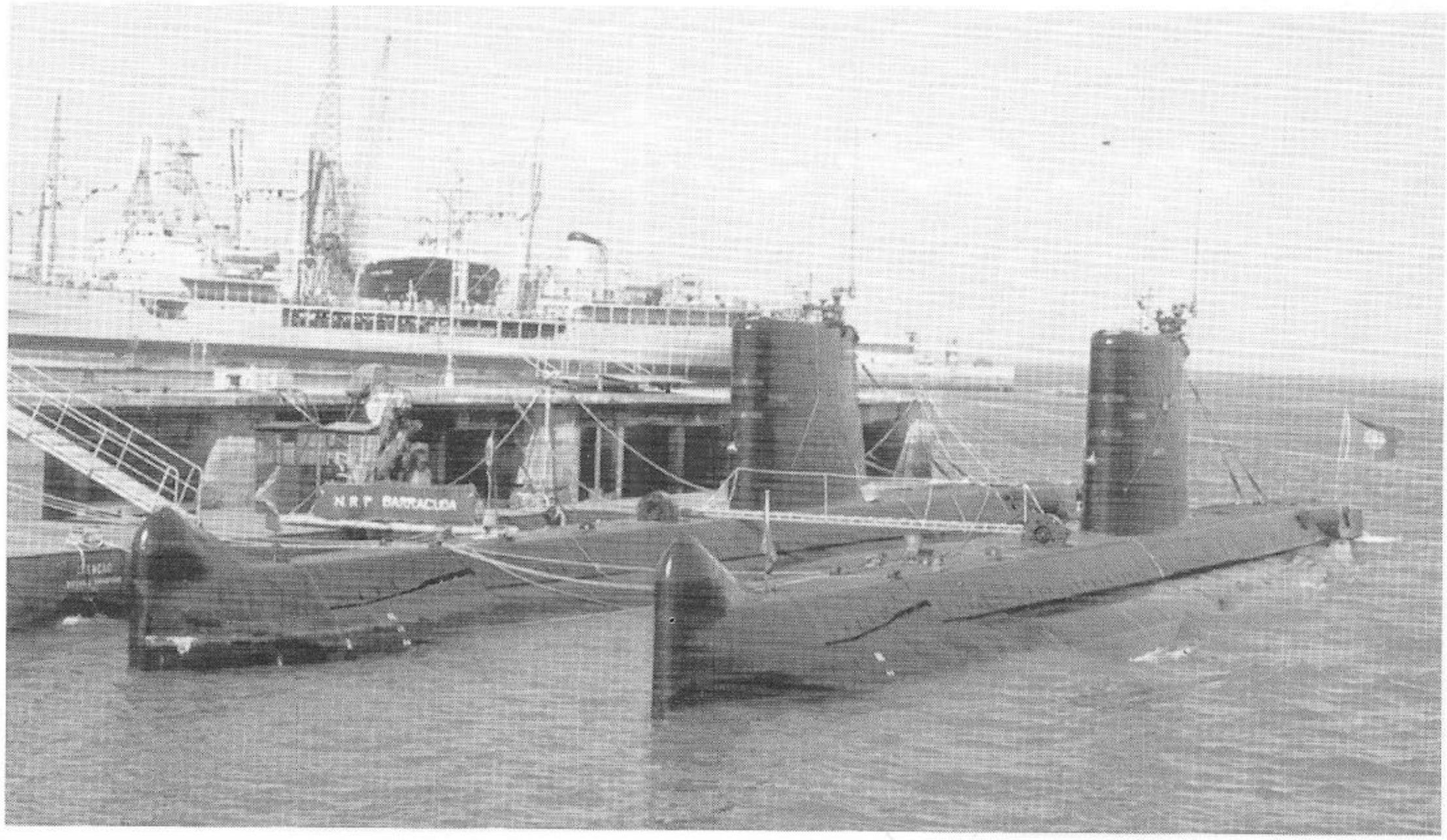
Builder	Dubigeon Normandie, Nantes, France
Laid down	6 Sep 1965
Launched	13 Oct 1966
Commissioned	1 Oct 1967

BARRACUDA (S 164)

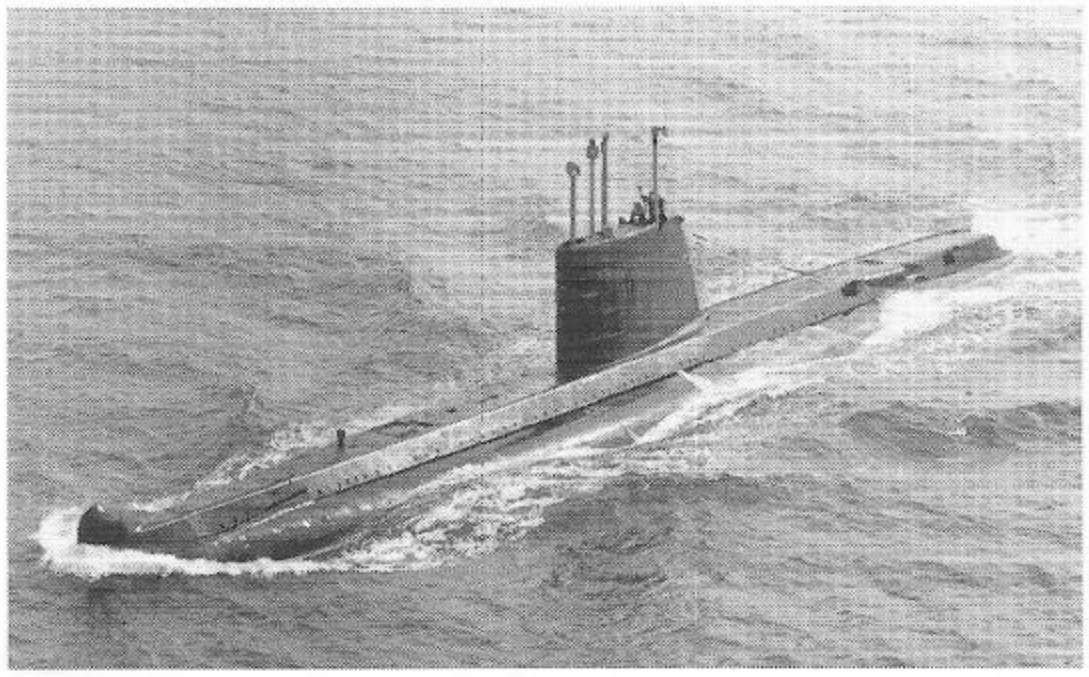
Builder	Dubigeon Normandie, Nantes, France
Laid down	19 Oct 1965
Launched	24 Apr 1967
Commissioned	4 May 1968

DELFIM (S 166)

Builder	Dubigeon Normandie, Nantes, France
Laid down	14 May 1967
Launched	23 Sep 1968
Commissioned	1 Oct 1969



Barracuda *(S 164) (left) and* Albacora *(S 163)* (H & L van Ginderen Collection)



The Portuguese 'Albacora' class has been in service since 1967-69 and is now overdue for replacement (Portuguese Navy)

Delfim *(S 166)* (H & L van Ginderen Collection)

WEAPONS SYSTEMS

TUBES

12–550 mm (21.7 in); eight bow, four stern tubes. Total weapon load, 12 (no reloads).

TORPEDOES

DCN E14/E15/L3 torpedoes

These Portuguese submarines have three types of somewhat elderly French torpedoes available to them, none of which remains in service with the French Navy. The L3 is an anti-submarine weapon for use against targets moving at depths of up to 300 m and speeds of up to 20 knots. E 14 and E 15 are both for use against surface ships and submarines running at periscope depth; they are very similar, but E 14 has a shorter range (5,000 m versus 13,000 m) and a less powerful warhead (200 kg versus 300 kg).

Manufacturer/Contractor

Direction des Constructions Navales (DCN), Saint Tropez, France.

Specifications

	E14	E15 Mod 2	L3
Entered service	1960	1958	1960
Length	4.279 m (14.0 ft)	5.9 m (19.36 ft)	4.3 m (14.10 ft)
Diameter	550 mm (21.6 in)	550 mm (21.6 in)	550 mm (21.6 in)
Weight	927 kg (2,044 lb)	1,387 kg (3,058 lb)	910 kg (2,006 lb)
Warhead	200 kg Tolite (441 lb)	300 kg Tolite Aluminium (661 lb)	200 kg Tolite Aluminium (441 lb)
Propulsion	electric (nickel-cadmium battery)	electric (silver-zinc battery)	electric (nickel-cadmium battery)
Speed	25 kts	31 kts	25 kts
Range	5.5 km (6,000 yd)	12 km (13,000 yd)	5.5 km (6,000 yd)
Acquisition range	500 m (1,640 ft)	2,000 m (6,562 ft)	1,000 m (3,281 ft)
Search depth		25 m (82 ft)	30 m (98 ft)
Attack depth	6-18 m presettable (20-60 ft)	6-18 m presettable (20-60 ft)	
Max depth rating	300 m (984 ft)	300 m (984 ft)	300 m (984 ft)
Guidance	Acoustic/passive, average range 500 m	Passive homing	Acoustic, active, range approx 600 m
Fuze	Impact/magnetic	Impact/magnetic	Impact/acoustic

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

ARUR/ARUD

ARUR/ARUD is the French Navy's version of Thomson-CSF's DR 2000U ESM system. The system detects pulse and continuous wave (CW) signals, and when coupled with the Dalia analyser is used as a basic ESM suite, under the company designation TMV 434. There are six DF antennas and one omni-antenna on a telescopic mast, and a processing control/display console inside the submarine. It provides a virtual 100 per cent probability of detection over the complete 360° of azimuth and gives instantaneous audio and video alerts. DR 2000U Mk 3, installed in the Agostas, is an improved version with better sensitivity. The Dalia analyser provides alarm analysis and identification facilities through a library of 1000 radar modes and parameters and is easily reprogrammable.

Manufacturer/Contractor

Thomson-CSF, RCM, Elancourt, France.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

DLT D3 torpedo control

The DLT-D3 torpedo fire-control system can launch all types of torpedo employed by the French Navy, including wire-guided, and can be expanded for anti-surface missile applications. Target data are fed to the system from onboard sensors (sonars, acoustic rangefinder and periscopes) and employs a CIMSA 15M125 general purpose digital computer, associated with a CRT display terminal. DLT-D3 operating programs permit tracking eight targets, simultaneous guidance of two wire-guided torpedoes and preparation for the launch of a third. Emergency launch of torpedoes is possible from either bow or stern station. DLT-D3 is served by one or two operators at the operations centre, a third operator at the bow station with possibly a fourth at the stern station.

Manufacturer/Contractor

Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, France.

RADAR

Kelvin Hughes Type 1007

The radar subsystem is provided by GEC-Marconi, with the Kelvin Hughes Type 1007, mounted on its own mast, providing the major input to the internal workstations and the navigation plot.

Specifications

Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 31 dB
Pulsewidth: 0.08/0.35/0.8 µs
Pulse repetition frequency: 1,600/800/400 pps
Scan rate: 26 rpm

Manufacturer/Contractor

Kelvin Hughes, Ilford, Essex, UK.

SONARS

DSUV 2H

DSUV 2 is a passive, medium-frequency sonar array mounted in the lower part of the bow, originally fitted in the French 'Daphné' class.

Manufacturer/Contractor

Thomson-CSF.

Thomson-CSF DUUA 2D

The DUUA 2D is an active search sonar located in the after edge of the sail. It operates as a searchlight at a frequency of 8 kHz at a maximum power of 30 kW. Narrowband receiver coverage is ±500 Hz around any selected frequency between 2 and 15 kHz while broadband coverage is between 2.5 and 15 kHz.

Manufacturer/Contractor

Thomson-CSF.

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 2 SEMT-Pielstick 12 PA4 V 185 diesels; 1.8 MW (2,450 hp(m))

Alternators: 2 Jeumont Schneider alternators; 1.7 MW
Electric motors: 2—1.9 MW (2,600 hp(m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

Portugal's first post-war submarines were three ex-British 'S' class, which were purchased from the UK in 1948. When they became due for replacement, Portugal ordered four of the successful 'Daphné' class, which were all built in France. They were basically similar to the French Daphné, but with minor modifications to suit Portuguese requirements.

MODERNISATION

Similar to French Daphné class but without the external modification to the hull. New radar fitted in 1993/94.

SALES

Having operated *Cachalote* (S 165) for six years, the Portuguese Navy sold it to Pakistan as *Ghazi* in 1975.

THE FUTURE

There has been repeated discussion about replacements for these three boats, with an in-service date of 1996 being mentioned. As of 1996, however, no order had been placed, although the funding has been earmarked. One of the leading possibilities is the French Scorpene design, which would be built by Bazán.

DAPHNE, SOUTH AFRICA

GENERAL SPECIFICATIONS

Country: South Africa

Class: MARIA VAN RIEBEECK
Type: Daphné

Purchased: 3
In service: 3

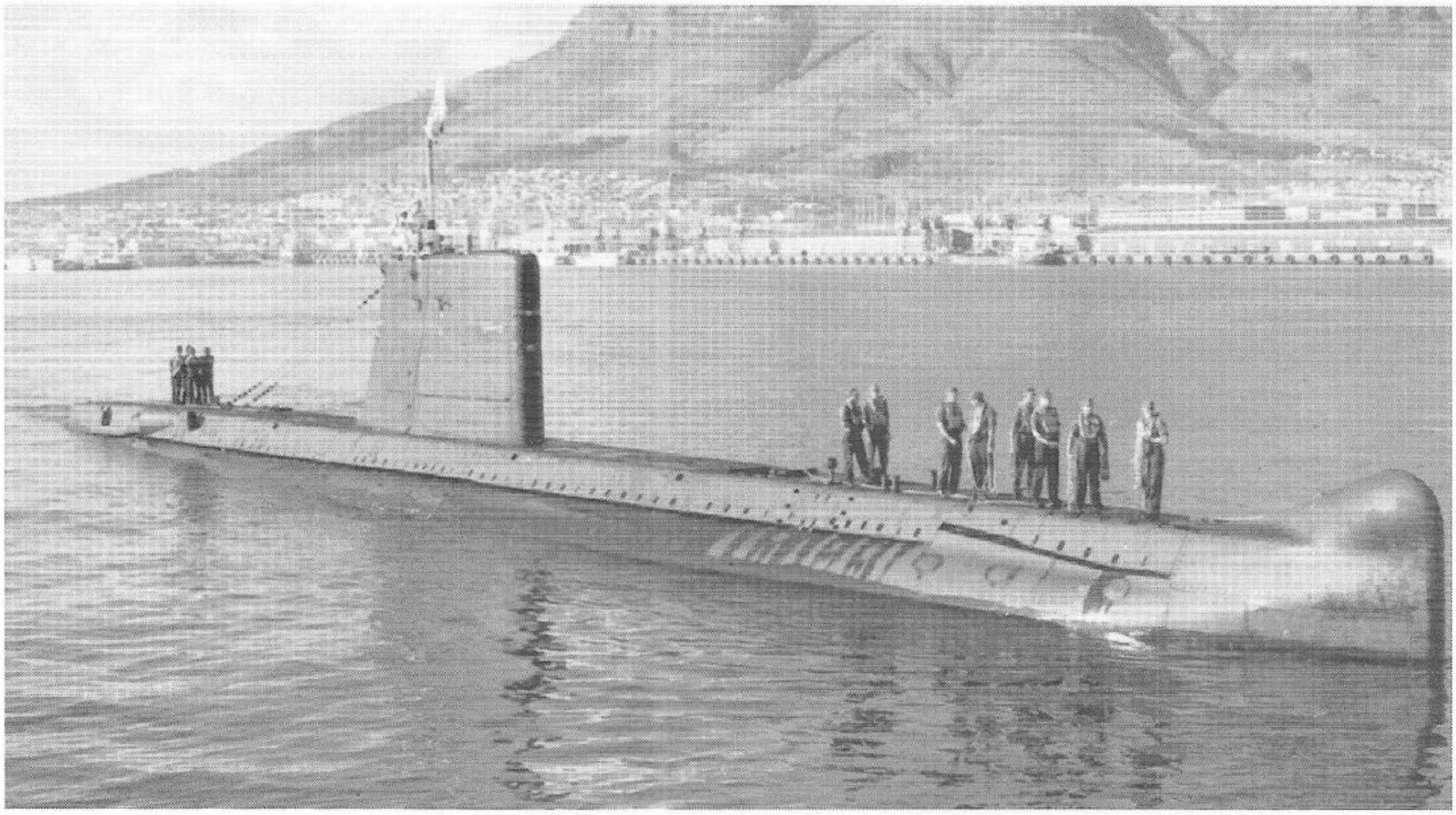
Displacement:
surfaced: 869 t
submerged: 1,043 t

Dimensions
Length: 57.8 m (189.6 ft)
Beam: 6.8 m (22.3 ft)
Draught: 4.6 m (15.1 ft)

Speed:
surfaced: 13.5 kts
submerged: 16 kts
Diving depth: 300 m (985 ft)
Range:
surfaced: 2,700 n miles at 12.5 kts
snorting: 4,500 n miles at 5 kts

Complement: 47 (6 officers)

SUBMARINES



Maria van Riebeeck *(S 97), one of three 'Daphné' class submarines in service with the South African Navy* (H & L van Ginderen Collection)

MARIA VAN RIEBEECK (S 97)

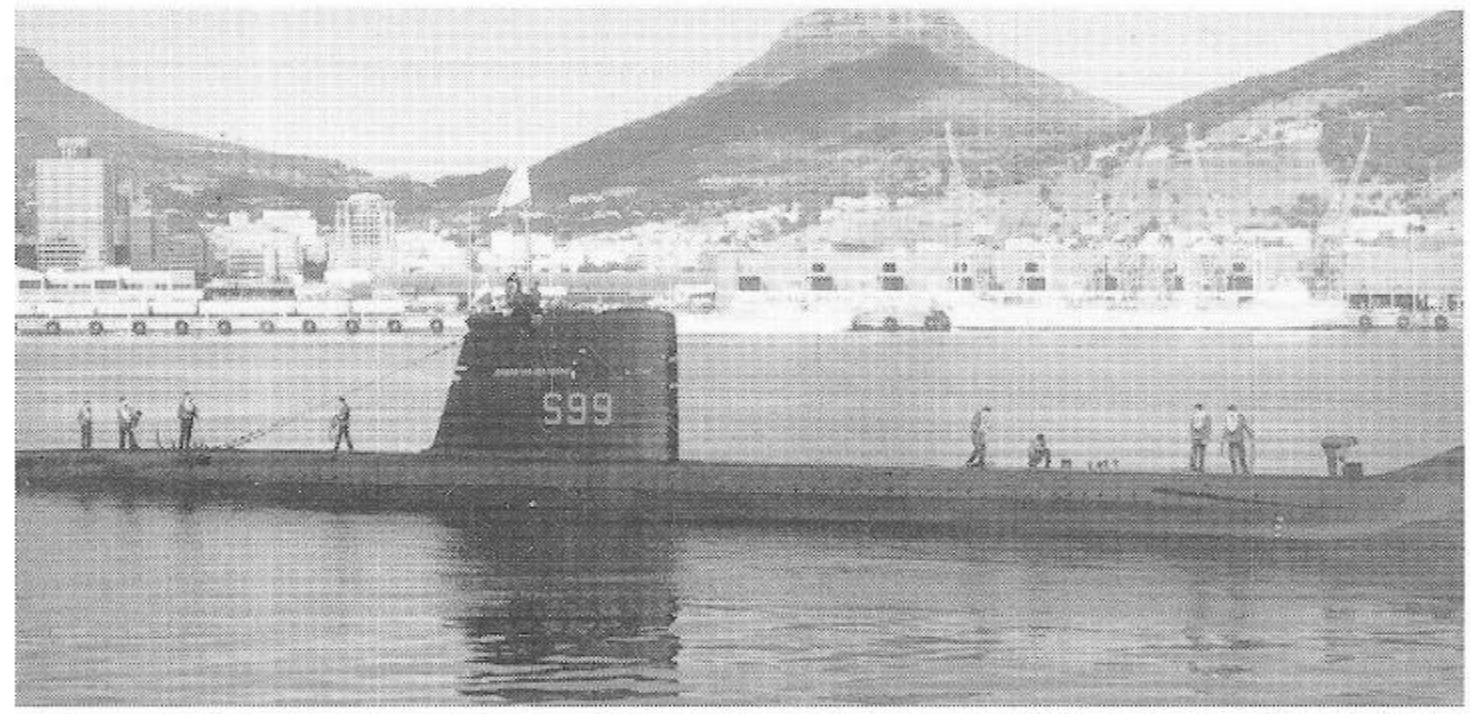
Builder	Dubigeon Normandie, Nantes, France
Laid down	14 Mar 1968
Launched	18 Mar 1969
Commissioned	22 Jun 1970

EMILY HOBHOUSE (S 98)

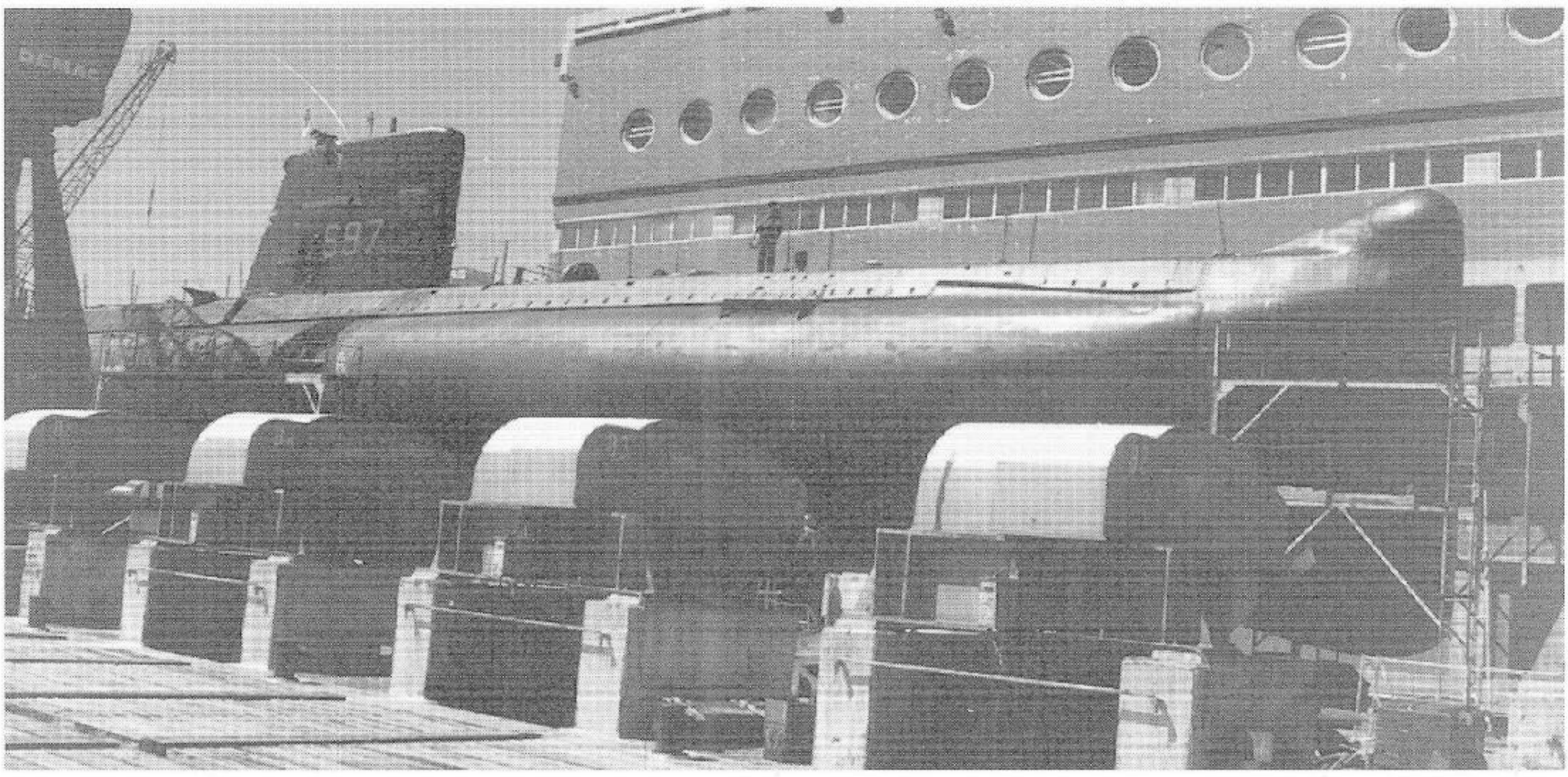
Builder	Dubigeon Normandie, Nantes, France
Laid down	18 Nov 1968
Launched	24 Oct 1969
Commissioned	25 Jan 1971

JOHANNA VAN DER MERWE (S 99)

Builder	Dubigeon Normandie, Nantes, France
Laid down	24 Apr 1969
Launched	21 Jul 1970
Commissioned	21 Jul 1971



Johanna van der Merwe *(S 99)* (H & L van Ginderen Collection)



Marie van Riebeeck *(S 97) ashore at the Simon's Town naval base. These three boats have been very carefully maintained and, considering their age, are in excellent condition* (David Miller)

WEAPONS SYSTEMS

TUBES

12–550 mm (21.7 in); eight bow, four stern tubes; hydraulic-ram launching.
Total weapon load, 12 (no reloads).

TORPEDOES

These South African submarines still nominally use French torpedoes, although considerable local development took place during the United Nations embargo period.

Manufacturer/Contractor
Direction des Constructions Navales (DCN), Saint Tropez, France.

Specifications

	E15 Mod 2	L5 Mod 3
Entered service	1958	1971
Length	5.9 m (19.36 ft)	5.5 m (18.0 ft)
Diameter	550 mm (21.6 in)	533 mm (can be increased to 550 mm)
Weight	1,387 kg (3,058 lb)	1,300 kg (2,866 lb)
Warhead	300 kg Tolite Aluminium (661 lb)	150 kg HE (331 lb)
Propulsion	Electric (silver-zinc battery)	Electric (silver-zinc battery)
Speed	31 kts	35 kts
Range	12 km	7.7 km
Max depth rating	300 m (984 ft)	500 m (1,640 ft)
Guidance	Passive homing	Active/passive
Fuze	Impact/magnetic	Acoustic/contact

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

ARUR/ARUD
ARUR/ARUD detects pulse and continuous wave (CW) signals and, when coupled with the Dalia analyser, is used as a basic ESM suite, under the company designation TMV 434. There are six DF antennas and one omni-antenna on a telescopic mast, and a processing control/display console inside the submarine. It provides a virtual 100 per cent probability of detection over the complete 360° of azimuth and gives instantaneous audio and video alerts.

Manufacturer/Contractor
Thomson-CSF, RCM, Elancourt, France.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Trivetts-UEC weapon control system
Emily Hobhouse is the first of these boats to be fitted with the Trivetts-UEC system, which is the second generation of submarine weapon control systems to have been designed and produced in South Africa. Software is by TechLogik of Durban and the fibre optic databus is provided by Plessey Tellumat.

Manufacturer/Contractor
UEC Projects, Kwazulu, Natal, Republic of South Africa.

RADAR

Thomson-CSF DRUA-33
DRUA-33 radar (also known as Calypso) carries out airspace and surface surveillance while the submarine is on the surface, and is also used for navigation. There is a single operating console below and the rotating antenna is positioned atop a mast to give maximum coverage. An earlier version, Calypso III, is quoted as being able to detect a 10 m^2 target, such as an ASW aircraft, at 18 n miles and a height of 2,500 m (8,200 ft)

Specifications
Role: Surveillance and navigation
Frequency bands: I/J
Pulse: 1 ms
Range: min 10 n miles
Peak output power: 25 kW

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

SONARS

Thomson-CSF DUUA 2A/B
The DUUA 2 is an active search sonar located in the after edge of the sail. It operates as a searchlight at a frequency of 8.4 kHz at a maximum power of 30 kW. Narrowband receiver coverage is ±500 Hz around any selected frequency between 2 and 15 kHz while broadband coverage is between 2.5 and 15 kHz.

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

Thomson-CSF DUUX 2
DUUX-2 is a passive rangefinding system, with three transducers along each side of the submarine. Target direction is obtained from the phase difference between the signals received by the three transducers. Operating frequency is 5, 7, 12 and 18 kHz and range accuracy is of the order of 10 per cent at 30 km, 2.5 per cent at 10 km and 1 per cent at 5 km.

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

DSUV 2H
DSUV 2 is a passive, medium-frequency sonar array mounted in the lower part of the bow, originally fitted in the French 'Daphné' class.

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

COMMUNICATIONS AND DATALINKS

Inmarsat C (receive only)
VLF/HF — Rohde & Schwarz TR 390
VHF B46 — Barlow.

PERSICOPES

The original periscopes have been totally refurbished and many elements replaced.

Manufacturer/Contractor
Eloptro, Kempton Park, Republic of South Africa.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 SEMT-Pielstick 12 PA4 V 185 diesels; 1.8 MW (2,450 hp(m))
Alternators: 2 Jeumont Schneider, 1.7 MW
Electric motors: 2–1.9 MW (2,600 hp(m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

These three boats were ordered from France in 1967 and delivered before the arms embargo was imposed. They were originally similar to those built for the French Navy but have been repeatedly refitted during the United Nations embargo period and now differ considerably from the original.

MODERNISATION

Like other equipment which had been obtained prior to the imposition of sanctions, these three submarines have been very carefully maintained by the South African Navy. Each boat has followed a cycle of five years in commission and then two years in deep refit at the Simon's Town naval base, with the most recent cycle having seen *Van der Merwe* completed in late 1990 and *Maria van Riebeeck* in mid-1993.

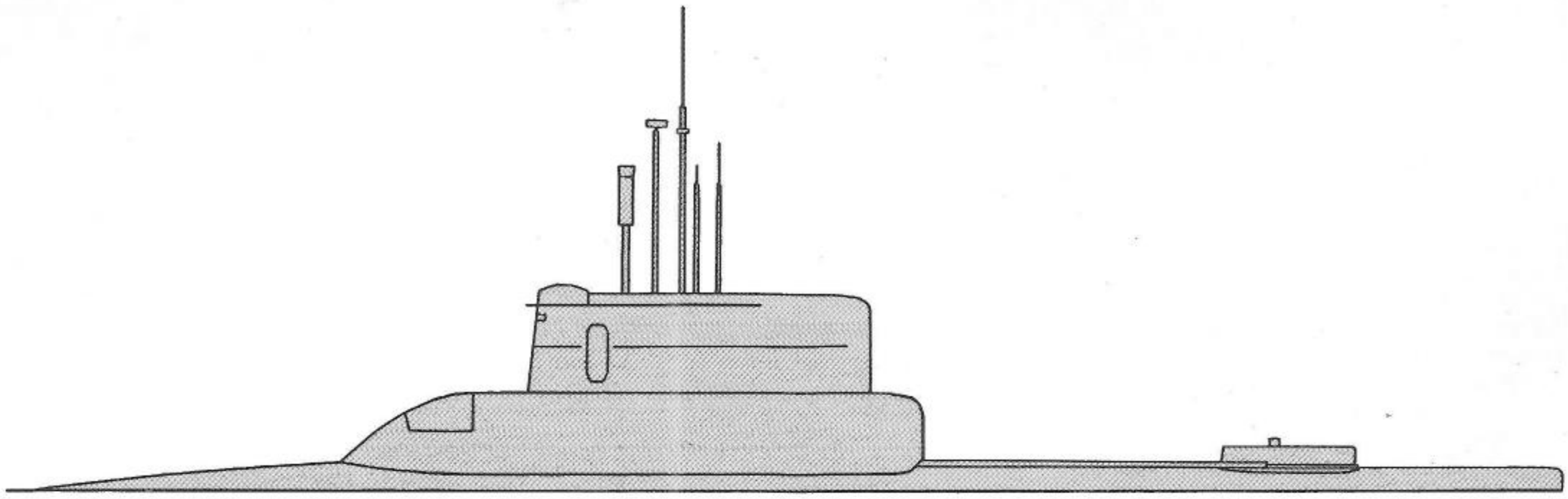
The third submarine, *Emily Hobhouse,* has recently completed the first of a new round of deep refits in 1994, which included installing a totally new sonar outfit by South African company UEC as well as totally refurbished periscopes from Eloptro.

These refits will enable these now elderly Daphnés to last until at least 2005. Much equipment is now of South African design and manufacture; the radio and electronic equipment, for example, is 95-100 per cent South African

THE FUTURE

Feasibility studies have been done to evaluate replacements, but the South African Navy's first priority is the procurement of new corvettes.

NARHVALEN



Narhvalen (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Denmark

Class: NARHVALEN

Built: 2
In service: 2

Displacement:
surfaced: 420 t
submerged: 450 t

Dimensions
Length: 44.3 m (145.3 ft)
Beam: 4.6 m (15 ft)
Draught: 4.2 m (13.8 ft)

Speed:
surfaced: 12 kts
submerged: 17 kts

Complement: 21 (4 officers)

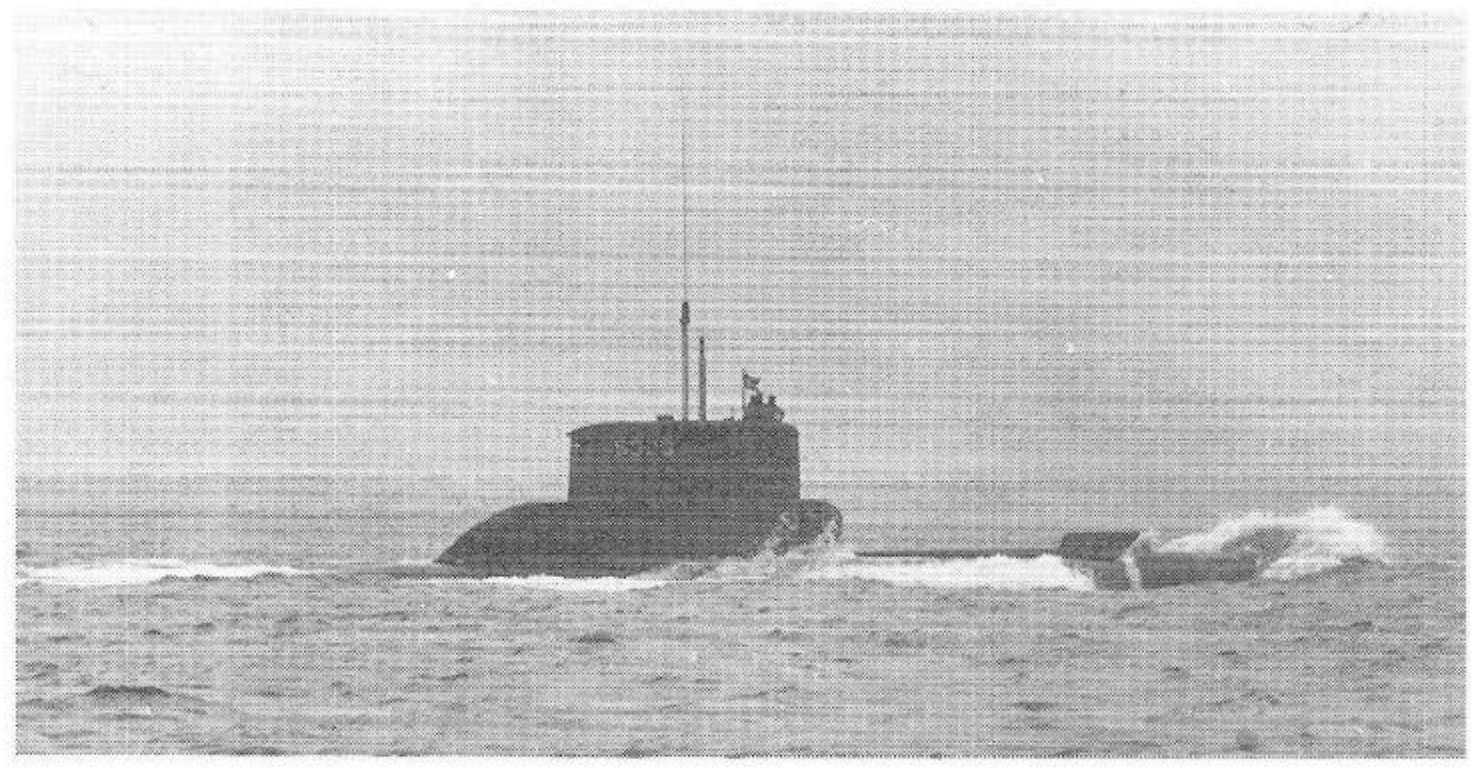
SUBMARINES

NARHVALEN (S 320)

Builder	Royal Dockyard, Copenhagen, Denmark
Laid down	16 Feb 1965
Launched	10 Sep 1968
Commissioned	27 Feb 1970

NORDKAPEREN (S 321)

Builder	Royal Dockyard, Copenhagen, Denmark
Laid down	4 Mar 1966
Launched	18 Dec 1969
Commissioned	22 Dec 1970



Nordkaperen *(S 321)* (Danish Navy)

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) bow tubes; swim-out.
Total weapon load, eight.

TORPEDOES

Bofors Tp 617

The Tp 617 wire-guided, long-range torpedo was developed by the then FFV company, using high-test peroxide technology bought-in from the UK, for use against surface targets. Passive homing.

Specifications
Length: 6.98 m (22.9 ft)
Diameter: 533 mm (21 in)
Weight: 1,860 kg (4,100 lb)
Performance: 13.7 n miles (25 km) at 45 kts
Propulsion: High-test peroxide (HTP)
Warhead: 240 kg (529 lb)

Manufacturer/Contractor
Bofors Underwater Systems, Motala, Sweden.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Racal Sea Lion

The Sea Lion ESM system provides radar warning and a high accuracy bearing search capability over the frequency range 0.5 to 18 GHz. It is wide open in bearing and frequency and offers a near 100 per cent probability of intercept. It uses an omnidirectional antenna array and a rotating antenna. The antennas are separate units and may be mounted on separate masts. The omnidirectional antennas provide signals for measurement of amplitude, pulsewidth, frequency and time of arrival of received radar pulses. Processing of this data, together with identification of the radar through the system library, provides the warning function of the ESM system. The rotating dish provides signals for direction-finding for passive targeting and surveillance.

Specifications
Frequency range: 0.5-18 GHz
DF accuracy: 1° RMS
Sensitivity: −60 dBmi
Dynamic range: 55 dB
Library: Up to 3000 emitter modes

Manufacturer/Contractor
Racal Radar Defence Systems, Chessington, UK.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Signaal M8/24

The M8 digital computer-based, fire-control system is standard fitting in all HDW submarines. The system accepts target data inputs from a range of sensors including radar, sonar, passive sound detection systems, periscope observation, consort reports and ship's own navigational data. The display has range scale settings for 20, 10 and 5 km, presenting the positions of all contacts from all sensors simultaneously. One or more sensors may be connected to the computer for torpedo engagement, and up to three targets may be attacked simultaneously. The computer is programmed to provide firing data for wire-guided, programmed, conventional, and other types of torpedo, and performs automatic calculation of target position, course and speed. The CRT display can give true motion, relative motion or off-centred presentation of the tactical situation.

Manufacturer/Contractor

Hollandse Signaalapparaten BV, Hengelo, Netherlands.

RADAR

These submarines are fitted with a Terma Skanter surface search radar.

Specifications

Band: I/J-bands
Horizontal beamwidth: <2°
Vertical beamwidth: 20° ±1°
Gain: 28.5 dB
Scan rate: <30 rpm

Manufacturer/Contractor

Terma Elektronic, Lystrup, Denmark.

SONAR

STN Atlas PSU-83

As part of their modernisation programme these two boats are being fitted with the PSU-83 passive sonar suite, which is designed for small- and medium-size submarines and uses a newly developed programmable and north-stabilised beamformer which can handle all types of hydrophone arrays.

Manufacturer/Contractor

STN Atlas Elektronik GmbH, Bremen, Germany.

PROPULSION

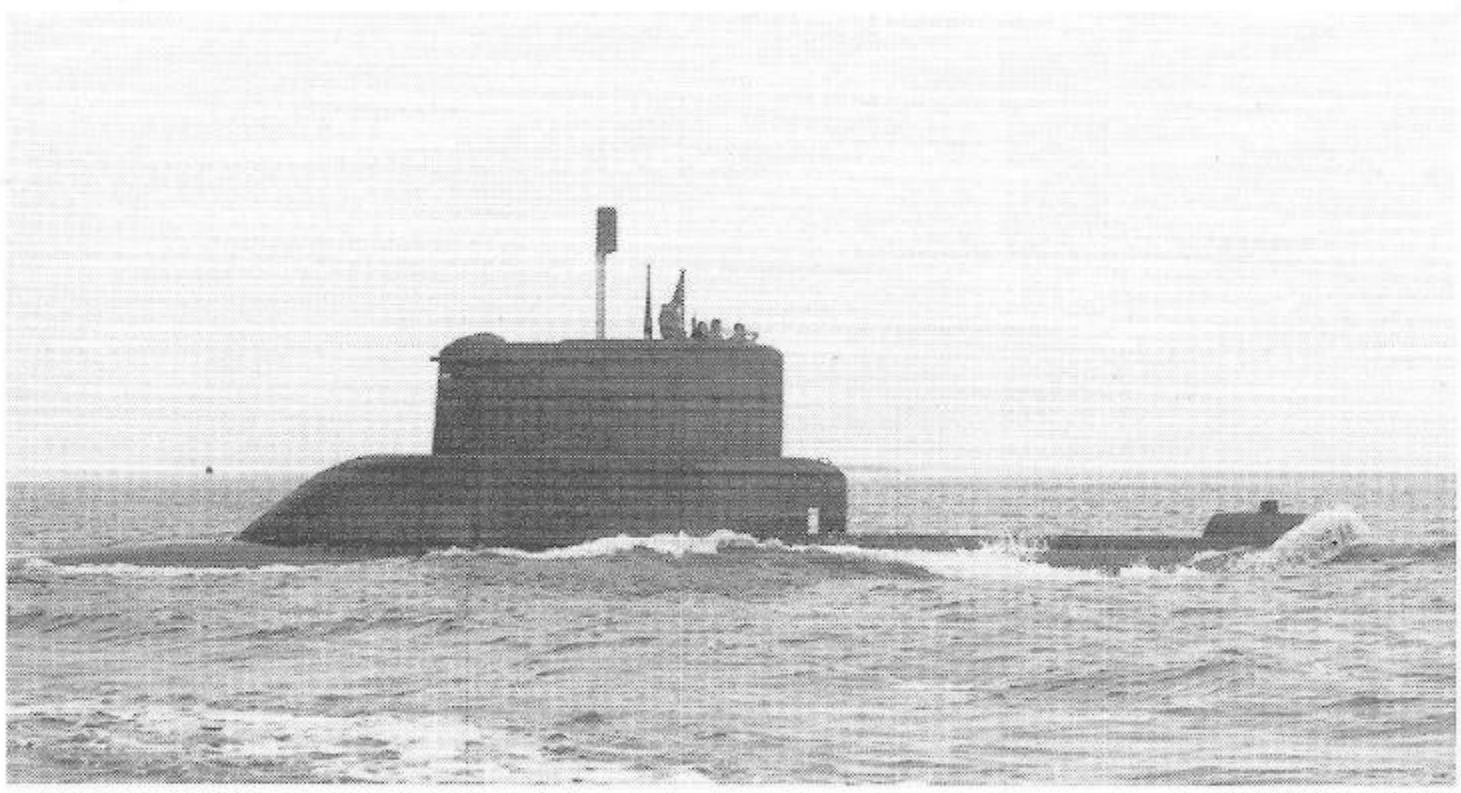
Specifications

System: Diesel-electric
Main engines: 2 MTU 12V 493 TY7; 1.62 MW (2,250 hp(m))
Propulsion motor: 1 Siemens; 882 kW (1,200 hp(m))
Shaft: 1
Batteries: Chloride Industrial Batteries, UK

FURTHER INFORMATION

PROGRAMME

Following the construction of four Danish-designed 'Delfinen' class submarines between 1954 and 1964, the Danish Navy decided that its next class would be a licence-built version of the German Type 205. Two were built at the Copenhagen Naval Dockyard, with the second being completed in 1970, since when no further submarines have been built in Denmark.



Narhvalen (S 320) (Danish Navy)

DESIGN

These coastal submarines are very similar to the German Improved Type 205.

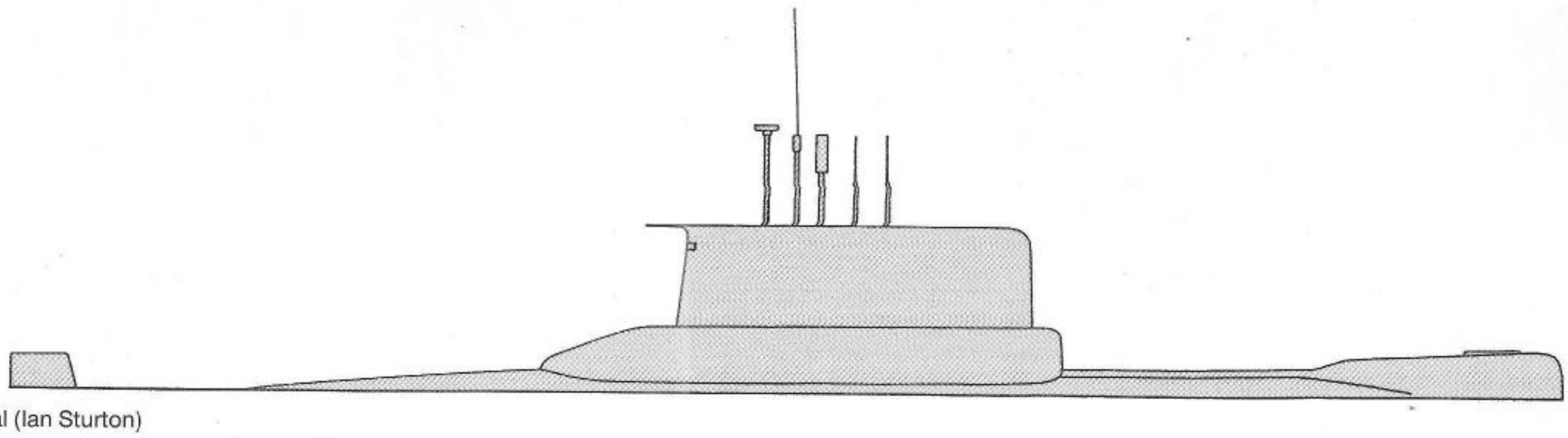
MODERNISATION

A programme is in hand for an equipment update similar to that given to the 'Tumleren' class, to enable both submarines to serve until the end of the decade. Work started on *Narhvalen* in late 1993 and was completed in February 1995, and started on *Nordkaperen* in mid-1995. The work involved includes new periscopes, a Sagem optronic mast, ESM, radar and sonar.

THE FUTURE

These submarines will be due for replacement in the first few years of the next century. One possibility would be another German design, such as the Type 212, but a lot of pressure is now being applied for a 'Nordic' design, in which Denmark, Norway and Sweden would co-operate on a joint project, possibly based on the Kockum's 'Submarine 2000' design.

GAL



Gal (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Israel

Class: GAL
Type: Vickers Type 540

Bought: 3
In service: 3

Displacement:
surfaced: 420 t
submerged: 600 t

Dimensions
Length: 45 m (146.7 ft)
Beam: 4.7 m (15.4 ft)
Draught: 3.7 m (12 ft)

Speed:
surfaced: 11 kts
submerged: 17 kts

Complement: 22

SUBMARINES

GAL (-)

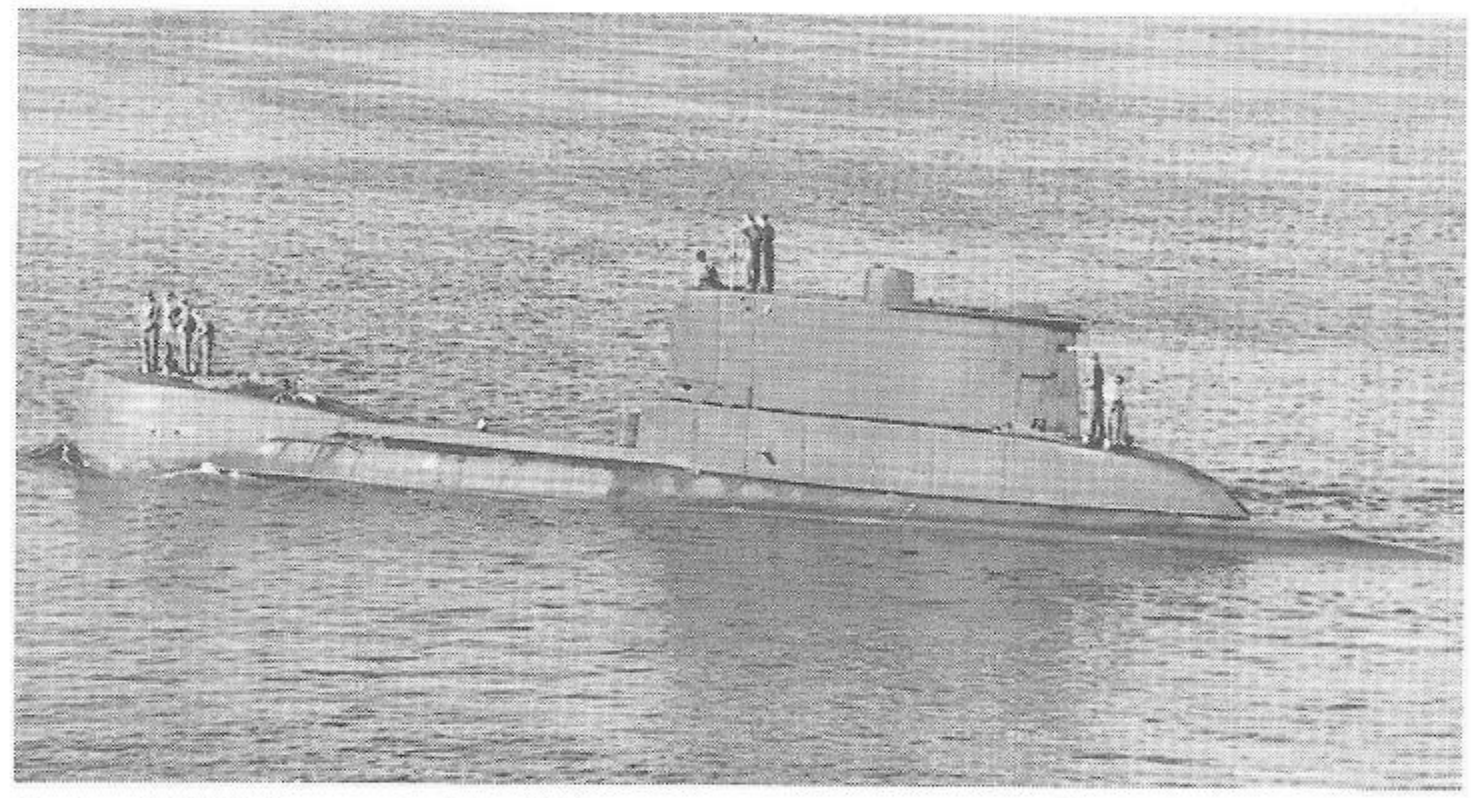
Builder	Vickers Ltd, Barrow-in-Furness, UK
Laid down	1973
Launched	2 Dec 1975
Commissioned	Jan 1977

TANIN (-)

Builder	Vickers Ltd, Barrow-in-Furness, UK
Laid down	1974
Launched	25 Oct 1976
Commissioned	Jun 1977

RAHAV (-)

Builder	Vickers Ltd, Barrow-in-Furness, UK
Laid down	1974
Launched	1977
Commissioned	Dec 1977



The Israeli 'Gal' class was built by VSEL in UK to a modified IKL Type 206 design. Uniquely among submarines they are painted blue/green to blend in with the waters of the eastern Mediterranean

WEAPONS SYSTEMS

ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Sub-Harpoon (S 135-136)

All three 'Gal' class boats have been adapted to carry and launch Sub-Harpoon. It is not known to which production block they belong.

Specifications
Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 kg)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

Eight 533 mm (21 in) torpedo tubes; swim-out.
Total weapon load, 10.

TORPEDOES

Alliant NT 37E

The NT 37E is a dual-purpose 485 mm diameter ASW and anti-ship torpedo and is a total redesign of the original US Navy Mk 37 torpedo, the only original element common to both being the torpedo hull. All the internal subsystems, including propulsion, sonar and guidance, have been completely replaced by new hardware and software. Compared to previous models, the new Otto-fuelled, thermochemical propulsion system gives a 40 per cent increase in speed, a 150 per cent increase in range, and an 80 per cent increase in endurance. A solid-state acoustic system and a noise-reduction, laminar-flow nose assembly replace the Mk 37's vacuum-tube acoustic panel and hemispherical nose. A new sonar substantially improves passive detection range against high-speed surface targets and active detection range against small silhouette submarine targets; in most cases, target acquisition range has been doubled. The new self-noise reduction nose assembly increases transducer isolation while reducing flow noise effects, thus reducing the likelihood of self-decoying at all depths.

Specifications
NT 37F Mod 2
Guidance: Wire-guided
Length: 4,505 mm (177 in)
Diameter: 485 mm (fits 533 mm launch tubes) (19 in)
Weight: 750 kg (1,654 lb)

Run modes: Straight run/salvo anti-ship; straight run with acoustic miss indicator to initiate acoustic re-attack; active snake and circle — ASW; passive snake and circle — anti-ship

Warhead: 150 kg HE
Fuze: Contact and proximity
Propulsion: Thermochemical rotary piston cam engine with Otto fuel

Manufacturer/Contractor
Alliant Techsystems, Marine Systems, Hopkins, Minnesota, USA.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Elisra NS 9034
The NS-9034 submarine ESM/ELINT radar warning system is designed to carry out threat detection and analysis in dense electromagnetic environments. The ESM mast incorporates a static antenna array, plus an optional fine DF array incorporating an RKR lens array. An omnidirectional array is also mounted on the periscopic mast. Coarse DF accuracy is 6°, while the use of an advanced multibeam static lens array provides a high-bearing accuracy for targeting of 1°. Elevation coverage is from −10 to +30°.

Specifications
Frequency range: 2-18 GHz
RKR lens array coverage: 7-18 GHz
Coarse DF accuracy: 6°
Targeting accuracy: 1°
Elevation coverage: −10 to +30°

Manufacturer/Contractor
Elisra Electronic Systems Limited, Bene Beraq, Israel.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

The original fire-control system was the Ferranti TIOS Atlas Elektronik TFCS. It is believed that this has been replaced by an STN Atlas system.

RADAR

It is known that the radar fitted is a Plessey (UK) system. The type is not known.

SONARS

Originally Atlas Elektronik hull and flank arrays were installed, but the flank array has since been replaced by the EDO 1110.

EDO 1110 flank array
EDO Model 1110 flank array uses two linear arrays, one down either side of the hull. More than 15 targets can be tracked simultaneously. The system was installed in the 'Gal' class during its mid-1990s refits.

Manufacturer/Contractor
EDO Corp, Salt Lake City, Utah, USA.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 MTU 12V 483 AZ80 GA31L diesels; 882 kW (1,200 hp(m)) sustained
Alternators: 2—810 kW
Motor: 1—1.32 MW (1,800 hp(m)) sustained
Shaft: 1

FURTHER INFORMATION

PROGRAMME

The Israeli Navy's first submarines were British: two surplus 'S' class boats which served from 1958 to 1972. These were replaced by three 'T' class boats, also ex-British wartime boats, of which two served from 1967/68 to the mid-1970s, although the third, *Dakar,* was lost during its delivery voyage on 25 January 1968, an event which has never been fully explained.

The replacements for the 'T' class were required in the late 1970s and after surveying the market the Israeli Navy selected the German IKL 500 design, but to be built by Vickers Ltd at Barrow-in-Furness in the UK.

DESIGN

The design of the Type 540 is based very closely on that of the IKL Type 206, but with a number of differences, of which the most obvious is the sail.

They were designed to be fitted with the Vickers SLAM (Submarine-Launched Air Defence Missile), which was essentially an automated six-missile Blowpipe launcher mounted in a watertight container on the top of the fin. The perceived requirement for SLAM was the same as that for the hand-held missile launchers in the sail of the Russian Type 877/636 submarines; namely, defence against maritime patrol aircraft and ASW helicopters. Unlike the Russian system, however, SLAM was never fitted as it was realised that the submarines were more likely to survive by using stealth and diving deep. It must also have added significantly to the top-weight of such a small submarine.

MODERNISATION

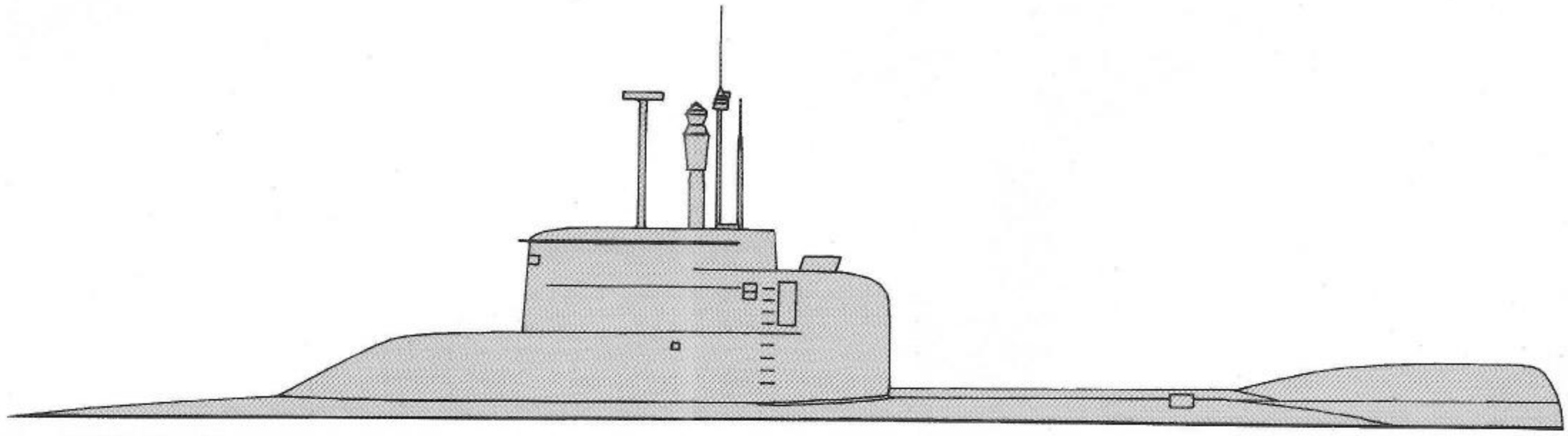
These submarines have been regularly updated. Sub-Harpoon and the associated fire-control equipment were installed in 1983, making them by far the smallest submarines to carry this weapon. New Alliant NT 37E torpedoes replaced the obsolete Honeywell Mk 37 in 1987-88. Updated sensors and fire-control equipment were fitted in 1994/95.

OPERATIONAL

These submarines are very small by contemporary standards and their 22-man crew must be very crowded. Nevertheless, it is planned that they will remain in service at least until the end of the century. They are painted blue/green to aid concealment in the central and eastern Mediterranean.

Their principle mission is reported to be defensive, providing early warning of sabotage raids or of enemy submarine incursions. The Israeli Defense Force is, however, renowned for its offensive actions and there is no reason why these submarines could not be used in a highly aggressive manner.

TYPE 206/TYPE 206A



Type 206/206A (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Germany

Class: TYPE 206/206A

Built: 18
In service: 12 (Type 206A)
In operational reserve: 5 (Type 206)
Awaiting decision: 1 (Type 206)

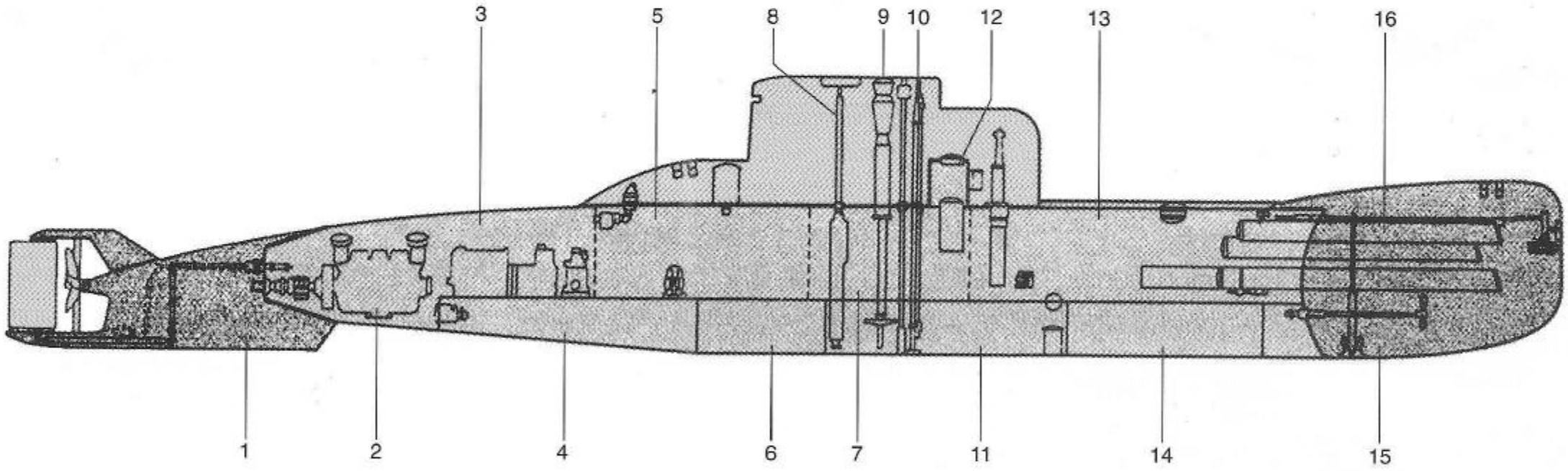
Displacement:
surfaced: 450 t
submerged: 498 t

Dimensions
Length: 48.6 m (159.4 ft)
Beam: 4.6 m (15.1 ft)
Draught: 4.5 m (14.8 ft)

Speed:
surfaced: 10 kts
submerged: 17 kts
Range: 4,500 n miles at 5 kts surfaced

Complement: 22 (4 officers)

SUBMARINES



Type 206
1 *Ballast tank* **2** *Diesel engine* **3** *Engine room* **4** *Diesel fuel bunker* **5** *Control room* **6** *Battery room #I* **7** *Operations centre* **8** *Radar mast* **9** *Snort mast* **10** *Periscope* **11** *Bunkers/ballast tank* **12** *Main access trunk* **13** *Crew accommodation* **14** *Battery room #II* **15** *Ballast tanks* **16** *Torpedo tubes*

Type 206 (unmodified)

U 13 (S 192)
Builder Howaldtswerke, Kiel, Germany
Laid down 15 Nov 1969
Launched 28 Sep 1971
Commissioned 19 Apr 1973

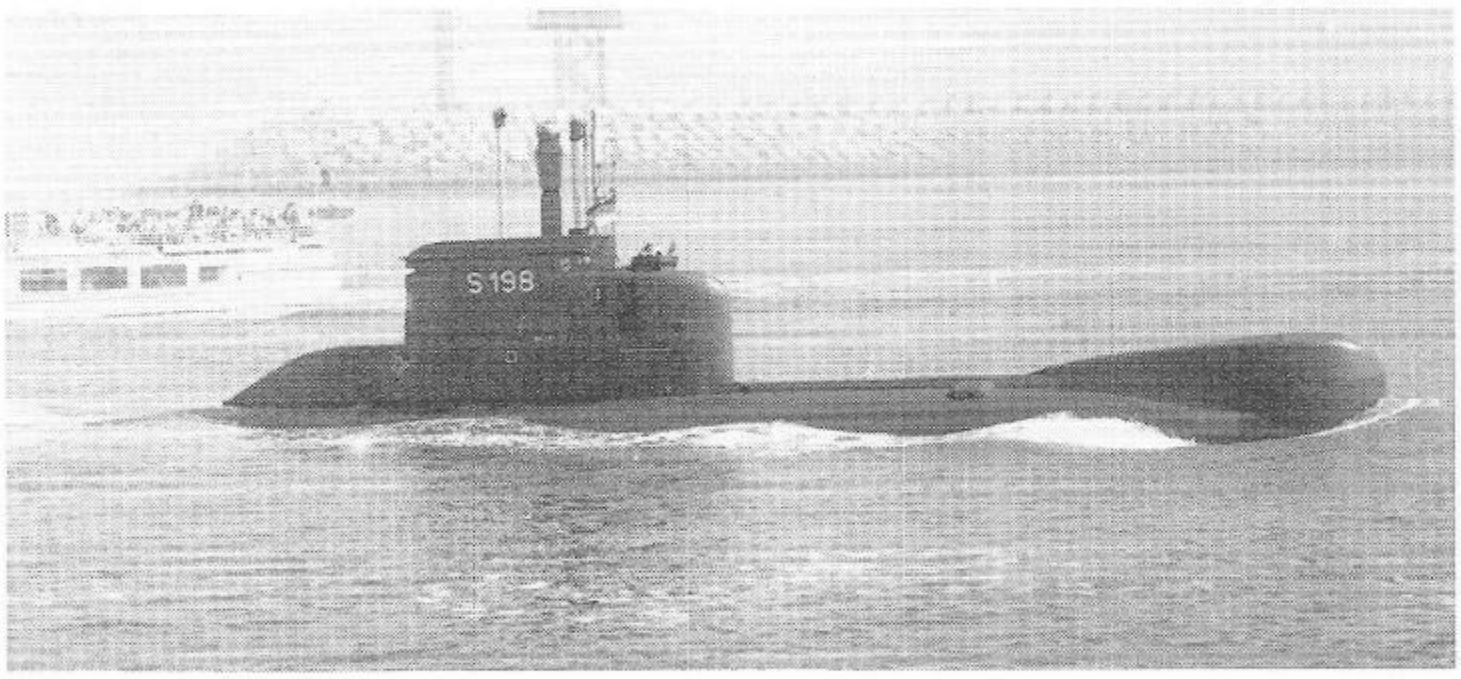
U 14 (S 193)
Builder Rheinstahl Nordseewerke, Emden, Germany
Laid down 1 Mar 1970
Launched 1 Feb 1972
Commissioned 19 Apr 1973

U 19 (S 198)
Builder Howaldtswerke, Kiel, Germany
Laid down 5 Jan 1971
Launched 15 Dec 1972
Commissioned 9 Nov 1973

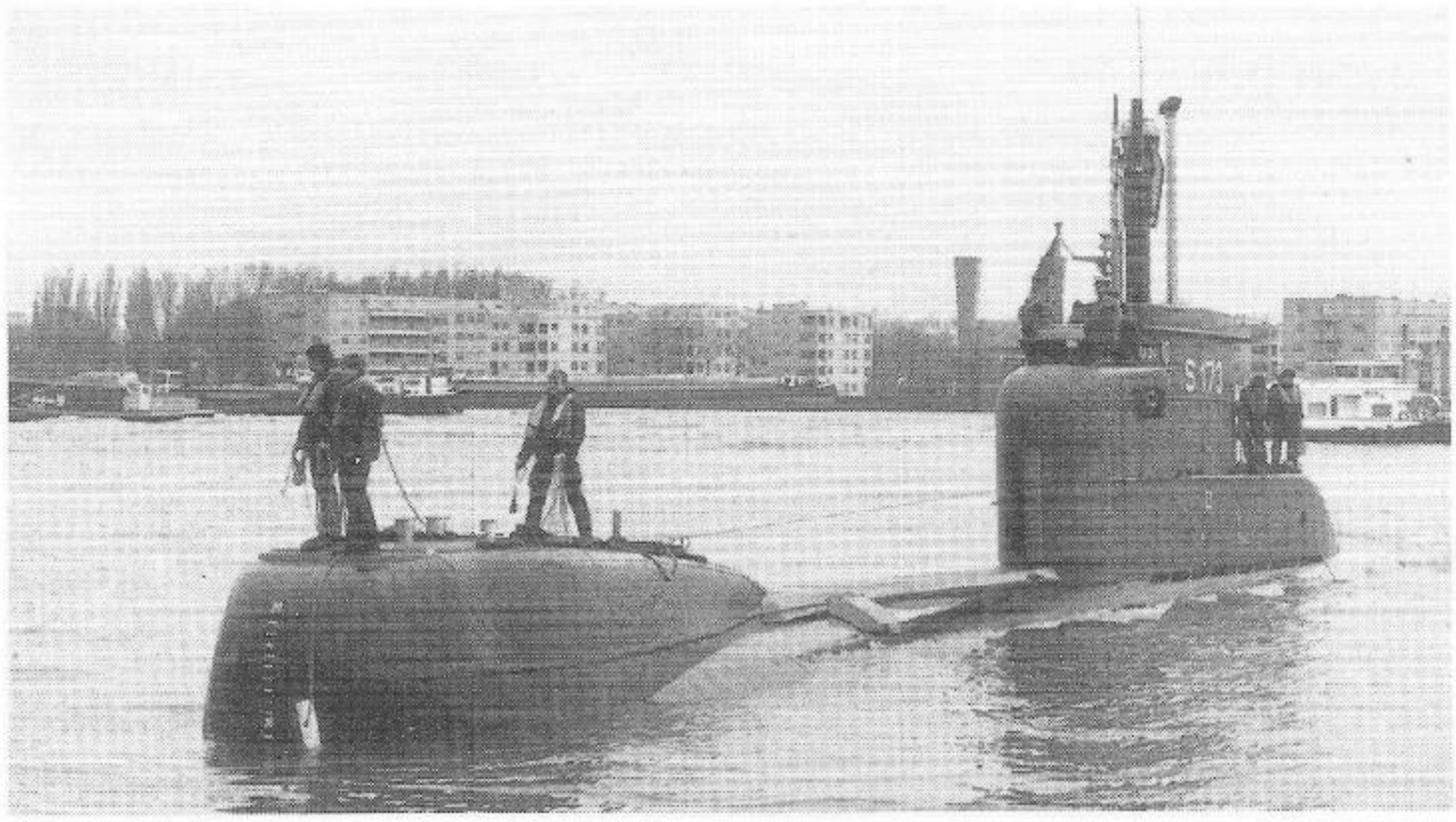
U 20 (S 199)
Builder Rheinstahl Nordseewerke, Emden, Germany
Laid down 3 Sep 1971
Launched 16 Jan 1973
Commissioned 24 May 1974

U13 *(S 192) in wintry conditions, with a special cover around the bow to protect the sonar from ice* (H & L van Ginderen Collection)

U14 *(S 193) is currently in a damaged state, having surfaced under a British frigate during NATO training off Portland, UK in January 1995* (H & L van Ginderen Collection)



U19 *(S 198), a standard Type 206. Note the large bow sonar dome, stepped sail and large 'bustle' at the after end of the sail* (H & L van Ginderen Collection)



U24 *(S 773); there is only a small amount of deck area available to the crew for such surface manoeuvres and the three men on the foredeck are secured by safety harnesses* (H & L van Ginderen Collection)

U 21 (S 170)

Builder	Howaldtswerke, Kiel, Germany
Laid down	15 Apr 1971
Launched	9 Mar 1973
Commissioned	16 Aug 1974

U 27 (S 176)

Builder	Howaldtswerke, Kiel, Germany
Laid down	1 Oct 1971
Launched	21 Aug 1973
Commissioned	16 Oct 1974

Type 206A (modified)

U 15 (S 194)

Builder	Howaldtswerke, Kiel, Germany
Laid down	1 Jun 1970
Launched	15 Jun 1972
Commissioned	17 Jul 1974

U 16 (S 195)

Builder	Rheinstahl Nordseewerke, Emden, Germany
Laid down	1 Nov 1970
Launched	29 Aug 1972
Commissioned	9 Nov 1973

U 17 (S 196)

Builder	Howaldtswerke, Kiel, Germany
Laid down	1 Oct 1970
Launched	10 Oct 1972
Commissioned	28 Nov 1973

U 18 (S 197)

Builder	Rheinstahl Nordseewerke, Emden, Germany
Laid down	1 Apr 1971
Launched	31 Oct 1972
Commissioned	19 Dec 1973

U 22 (S 171)

Builder	Rheinstahl Nordseewerke, Emden, Germany
Laid down	18 Nov 1971
Launched	27 Mar 1973
Commissioned	26 Jul 1974

U27 *(S 176) and* U30 *(S 179) are both Type 206A submarines. Note in these two pictures that* U30 *(S 179) is carrying a mine 'girdle' consisting of two boxes, each of which contains 12 mines. The boxes are held in place by metal straps and can be jettisoned either at the end of the minelaying mission or earlier in an emergency* (H & L van Ginderen Collection)

U 23 (S 172)

Builder	Rheinstahl Nordseewerke, Emden, Germany
Laid down	5 Mar 1973
Launched	25 May 1974
Commissioned	2 May 1975

U 24 (S 173)

Builder	Rheinstahl Nordseewerke, Emden, Germany
Laid down	20 Mar 1972
Launched	26 Jun 1973
Commissioned	16 Oct 1974

U 25 (S 174)

Builder	Howaldtswerke, Kiel, Germany
Laid down	1 Jul 1971
Launched	23 May 1973
Commissioned	14 Jun 1974

U 26 (S 175)

Builder	Rheinstahl Nordseewerke, Emden, Germany
Laid down	14 Jul 1972
Launched	20 Nov 1973
Commissioned	13 Mar 1975

U 28 (S 177)

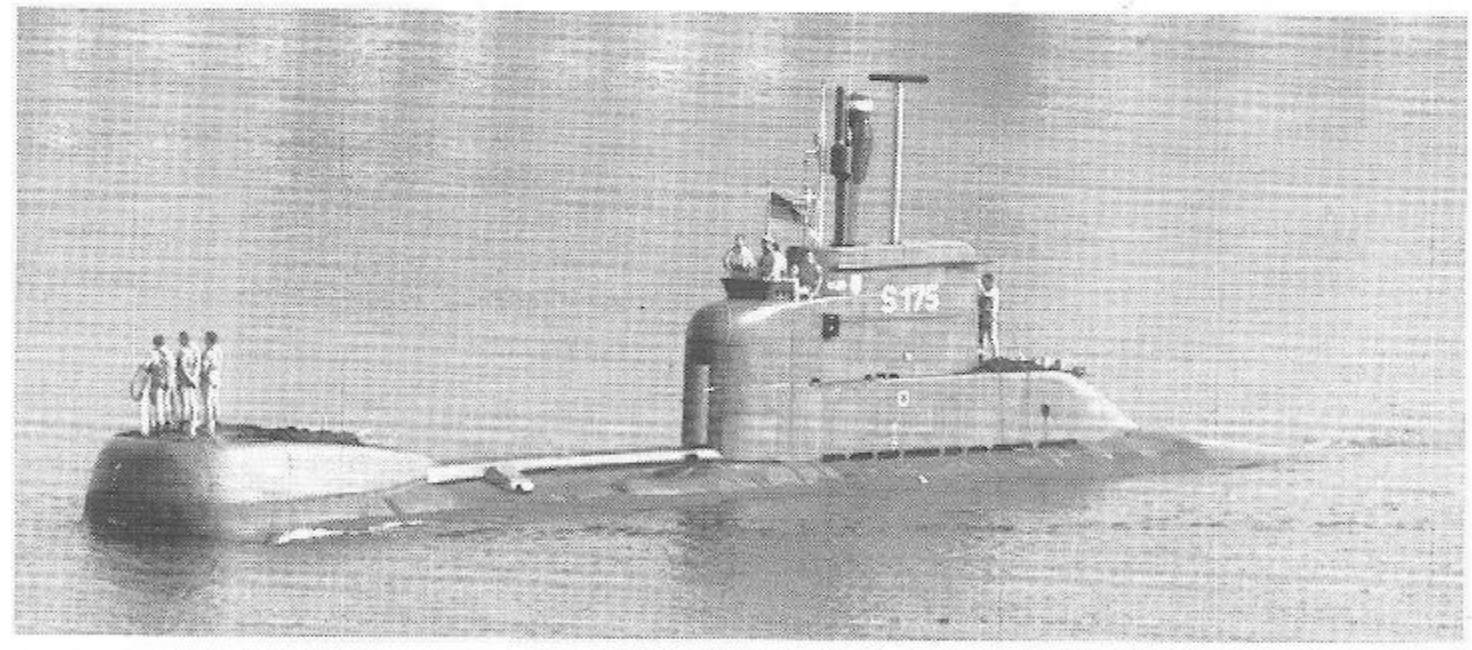
Builder	Rheinstahl Nordseewerke, Emden, Germany
Laid down	4 Oct 1972
Launched	22 Jan 1974
Commissioned	18 Dec 1974

U 29 (S 178)

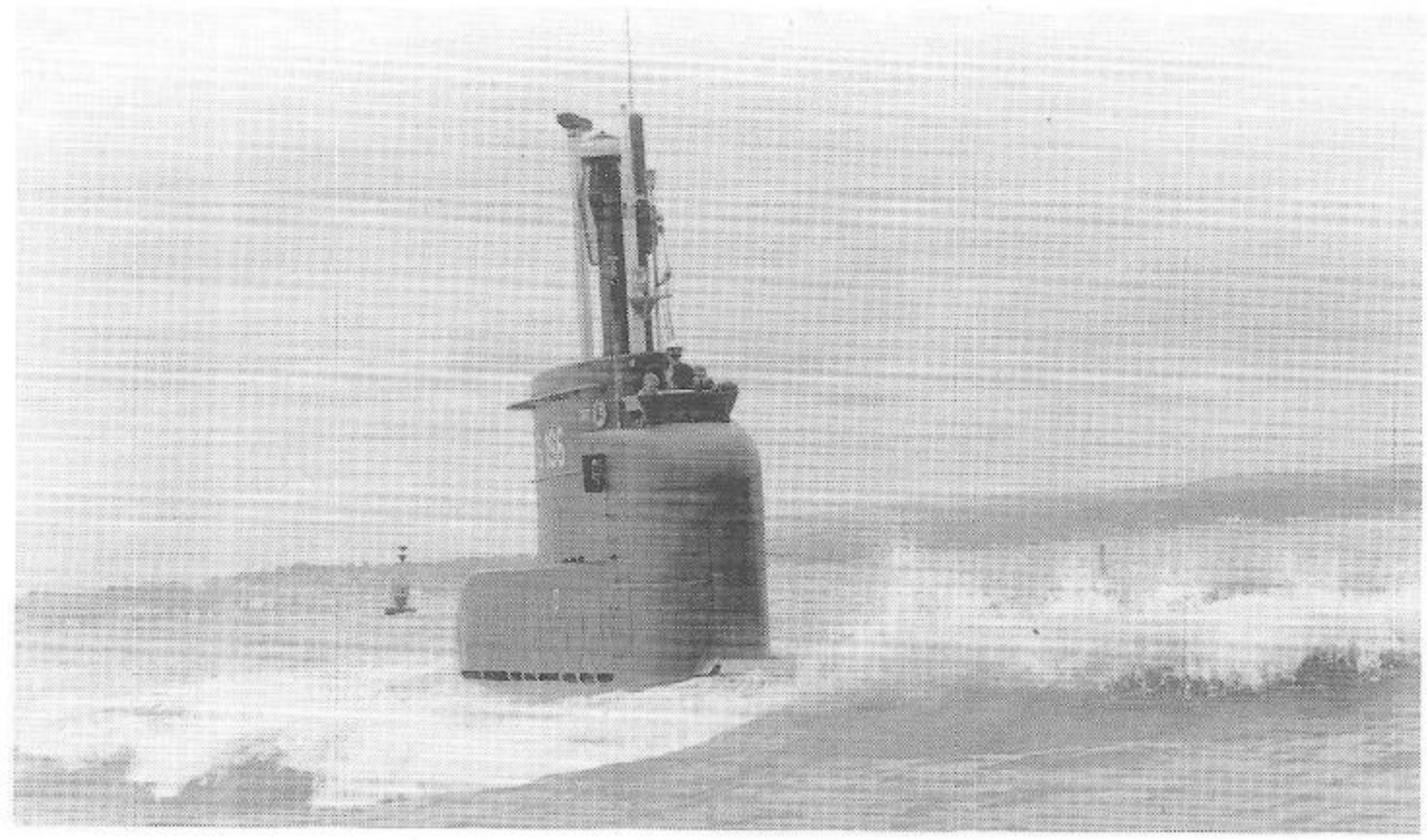
Builder	Howaldtswerke, Kiel, Germany
Laid down	10 Jan 1972
Launched	5 Nov 1973
Commissioned	27 Nov 1974

U 30 (S 179)

Builder	Rheinstahl Nordseewerke, Emden, Germany
Laid down	5 Dec 1972
Launched	26 Mar 1974
Commissioned	13 Mar 1975



U26 (S 175) in a Mediterranean harbour, demonstrating that these 'coastal' submarines have a 'blue water' capability when it is needed (H & L van Ginderen Collection)



U17 (S 196) at speed, with all its various masts in the raised position. Note also that the commanding officer alone wears a white cover on his cap, a tradition stretching back to the earliest days of the U-boat arm (H & L van Ginderen Collection)

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) bow tubes; swim-out.
Total weapon load, eight torpedoes.

TORPEDOES

STN Atlas DM1, DM2A1, DM2A3

DM1 and DM2A1 torpedoes are wire-guided, heavyweight, 21 in (533 mm) torpedoes, which are used in both Type 206 and Type 206A submarines: DM1 Seeschlange (sea-snake) is an anti-submarines version and DM2A1 Seeaal(sea-eel) is for the anti-ship role. There is a high degree of equipment commonality between the two, the major differences being that DM1 has half the propulsion battery capacity of DM2A1 Seeaal, but is fitted with three-dimensional sonar. They are electrically propelled, providing long range and selectable speeds.

All essential data are sent to the torpedo throughout its run via the dual-core guidance wire, while torpedo running data are simultaneously transmitted back to the submarine. Attack options following acquisition are either by manual or computer control from the submarine, or by self-homing by the torpedo.

Many DM2s are being upgraded to DM2A3 Seehecht (sea-pike) standards. This new version includes longer guidance wire, more silent running and a new inertial unit, as well as an improved fuze with high resistance to countermeasures. There are skew-bladed propellers of a new design, each with five glassfibre-reinforced plastic blades. DM2A3 also features improved two-way communications. The weapon is more flexible and the sensors are more accurate, with a wider range of preset tactical scenarios.

A further modification, the DM2A4 with improved propulsion, is due in service in 1998.

Specifications

	DM1 Seeschlange	DM2A1 Seeaal	DM2A3 Seehecht
Length	4.15 m (13.6)	6.08 m (19.94)	6.6 m (21.65 ft)
Diameter	533 mm (21 in)	533 mm (21 in)	533 mm (21 in)
Warhead	100 kg (220 lb)	250 kg (551.1 lb)	260 kg (573.2 lb)
Weight	1,370 kg (3,020 lb)	1,370 kg (3,020 lb)	1,370 kg (3,020 lb)
Performance			
active homing	3.3 n miles (6 km)/35 kts	3.3 n miles (6 km)/35 kts	7 n miles (13 km)/35 kts
passive homing	7.6 n miles (14 km)/23 kts	7.6 n miles (14 km)/23 kts	15 n miles (28 km)/23 kts

Manufacturer/Contractor
STN Atlas, Bremen, Germany.

MINES

A maximum of 24 ground-laid or 16 anchored mines can be carried in lieu of torpedoes, plus 24 mines carried in external, detachable boxes. (See 'Further Information').

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Type 206 and Type 206A

Thomson-CSF DR-2000U

Both Type 206 and Type 206A are fitted with DR-2000U which was introduced in 1977 and is very widely used in submarines. There are 6 direction-finding antennas and there is a threat library designated Dalia.

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

Type 206A

Thorn-EMI SARIE

In the Type 206A the DR-2000U is supported by SARIE (Selective Automatic Radar Identification Equipment) which provides the results of an automatic comparison of intercepted signal characteristics with a flexible dictionary of radar parameters in approximately 350 ms.

Manufacturer/Contractor
Thorn-EMI Electronics, Sensors Group, Crawley, UK.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Signaal M8/24

The M8 digital computer-based, fire-control system is standard fitting in all HDW submarines. The system accepts target data inputs from a range of sensors including radar, sonar, passive sound detection systems, periscope observation, consort reports and ship's own navigational data. The display has range scale settings for 20, 10 and 5 km, presenting the positions of all contacts from all sensors simultaneously. One or more sensors may be connected to the computer for torpedo engagement, and up to three targets may be attacked simultaneously. The computer is programmed to provide firing data for wire-guided, programmed, conventional, and other types of torpedo, and performs automatic calculation of target position, course and speed. The CRT display can give true motion, relative motion or off-centred presentation of the tactical situation.

Manufacturer/Contractor
Hollandse Signaalapparaten BV, Hengelo, Netherlands.

Thomson-CSF DRUA-33

DRUA-33 radar (also known as Calypso II) carries out airspace and surface surveillance while the submarine is on the surface, and is also used for navigation. There is a single operating console below and the rotating antenna is positioned atop a mast to give maximum coverage. An earlier version, Calypso III, is quoted as being able to detect a 10 m² target, such as an ASW aircraft, at 18 n miles and a height of 2,500 m (8,200 ft)

Specifications
Role: Surveillance and navigation
Frequency bands: I/J
Pulse: 1 ms
Peak output power: 25 kW
Range: 17 n miles (31 km) for 10 m² target

Manufacturer/Contractor
Thomson-CSF Systèmes Navals de Combat, Bagneux, France.

SONARS

Type 206

The unmodified Type 206s are fitted with elderly equipment including:
WSU sonar suite
AN 410A4 active sonar
GHG AN 5039A1 passive sonar

Type 206A

Thomson-CSF DUUX 2

DUUX-2 is a passive rangefinding system, with three transducers along each side of the submarine. Target direction is obtained from the phase difference between the signals received by the three transducers. Operating frequency is 5, 7, 12 and 18 kHz and range accuracy is of the order of 10 per cent at 30 km, 2.5 per cent at 10 km and 1 per cent at 5 km.

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

Safare VELOX sonar intercept

The VELOX is designed to intercept signals in the frequency range 2.5 to 100 kHz, and the signals are automatically measured to provide direction, level, frequency and pulse length, and to identify recurring identical pulses. There is a small external receiver array.

Manufacturer/Contractor
Safare Crouzet, Nice, France.

EDO-900 active mine avoidance sonar

The EDO 900 is a small sonar optimised for detecting underwater objects, in particular, mines. As far as is known, the German Navy's Type 206s are the only non-US submarines to use this equipment.

Manufacturer/Contractor
EDO, College Point, New York, USA.

STN Atlas DBQS-21

DBQS-21 (CSU 83) submarine sonar is the primary sensor of the submarine fire-control and command system and consists of a passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array, a sonar intercept array and two 'self-noise' detectors.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen, Germany.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 MTU 12V 493 AZ80 GA31L diesels; 882 kW (1,200 hp(m)) sustained
Alternators: 2 — 810 kW

Electric motor: 1 Siemens motor; 1.32 MW (1,800 hp(m)) sustained
Shaft: 1
Battery: 3 groups, each of 92 cells

FURTHER INFORMATION

PROGRAMME

Ten Type 205 submarines were constructed between 1962 and 1968 with hulls constructed of a new non-magnetic steel. The early boats, however, suffered from cracking due to stress corrosion and an urgent programme was initiated to develop a new steel which overcame these problems, which received a lot of publicity at the time. The new high-strength, non-magnetic, austenitic steel has greater elasticity and good dynamic strength, and has proved very satisfactory in service, thoroughly overcoming the doubts that were raised by those early problems, although it has never been selected by IKL's many export customers and thus remains unique to German Navy submarines.

The Type 206 was designed by IKL, the German design bureau, in 1964-65 and a production order was placed on 7 June 1969 for eight from Howaldtswerke Deutsche Werft (HDW) in Kiel and ten from Rheinstahl Nordseewerke in Emden.

MINES

The Type 206 does not carry any reload torpedoes and so if mines are to be carried internally this can only be done on a basis of three ground-lying mines or two anchored mines per tube. Such a system has a number of disadvantages, perhaps the most important of which is that it leaves the submarine relatively defenceless, due to a lack of torpedoes. In addition to this, swim-out tubes are less suitable than other types for minelaying, since a compressed air ejection system must be added.

To overcome these problems, IKL developed a strap-on minelaying 'girdle' consisting of two separate boxes, each containing 12 vertical mine tubes. The mines are loaded from above and are held in place by a hydraulically operated latch, controlled from inside the submarine. The boxes are free-flooding and on release of the latch the mine descends under gravity. Whether full or empty, the boxes can be jettisoned in an emergency.

MODERNISATION

A major mid-life modernisation was conducted on twelve of these submarines, the boats concerned now being officially designated Type 206A. The work started in mid-1987 and completed in February 1992, being carried out by:

Thyssen Nordseewerke, Emden — U 23, 30, 22, 27, 15, 26
HDW, Kiel — U 29, 16, 25, 28, 17, 18

The STN Atlas DBQS-21D sonar has been fitted, together with new periscopes, and a new weapon control system (LEWA). The ESM system has been replaced and a GPS navigation installed.

The rebuilt submarines are armed with new torpedoes (Seeaal), and the propulsion system has been comprehensively refurbished, and improvements have been made to the accommodation.

OPERATIONAL

The six unmodernised Type 206 are based at Kiel, Germany, where they are maintained in 'operational reserve' with cadre crews, only receiving full crews for exercises/operations.

The twelve Type 206As are based at the traditional U-boat base at Eckernförde.

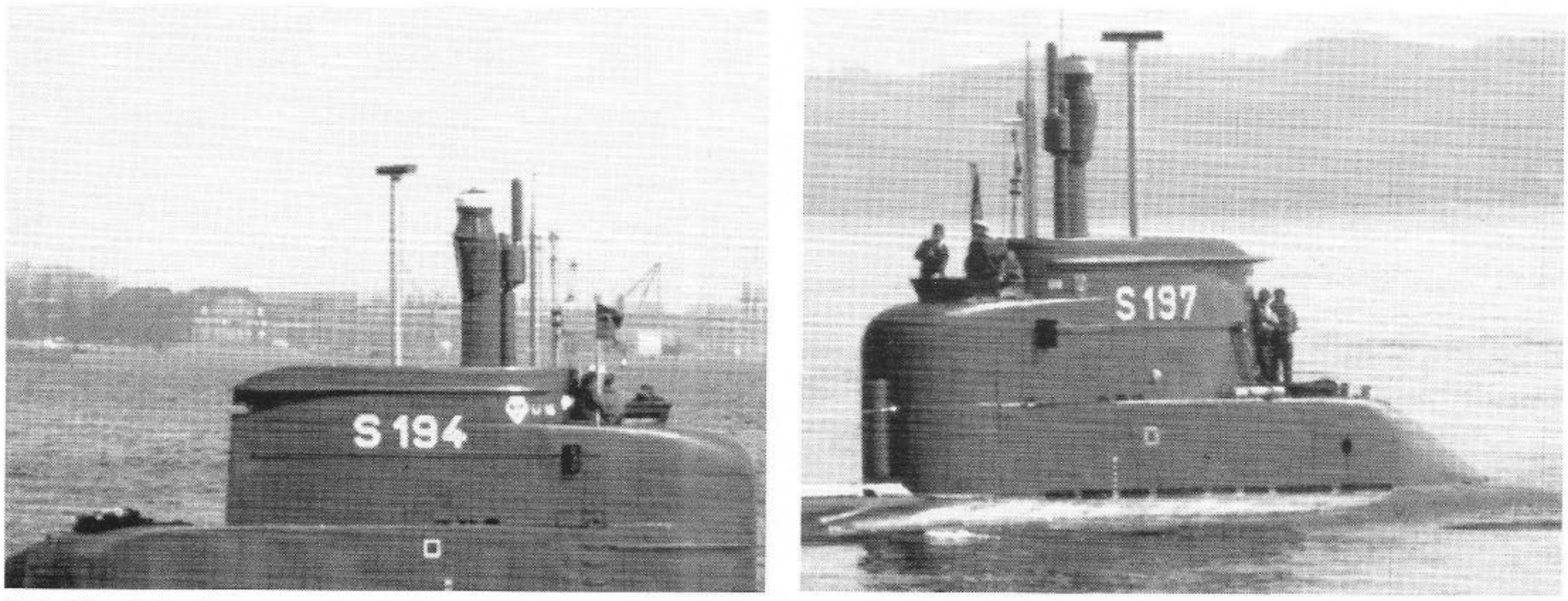
On 24 January 1995 U 14 was taking part in allied training off the Portland naval base when it surfaced underneath British frigate, Battleaxe. At the time both were reported to have suffered 'superficial damage' but it has subsequently been suggested that U 14 may be scrapped early as a result of the accident. U 14 is not one of the modified submarines.

SALES

There were reports that some of this class might be sold to the Singaporean Navy. It was reported at the time that the Singaporeans were asking for performance guarantees that the German vendors were unable to give and the subsequent sale of one Swedish 'Sjoormen' class submarine to Singapore in 1995 has presumably overtaken these plans.

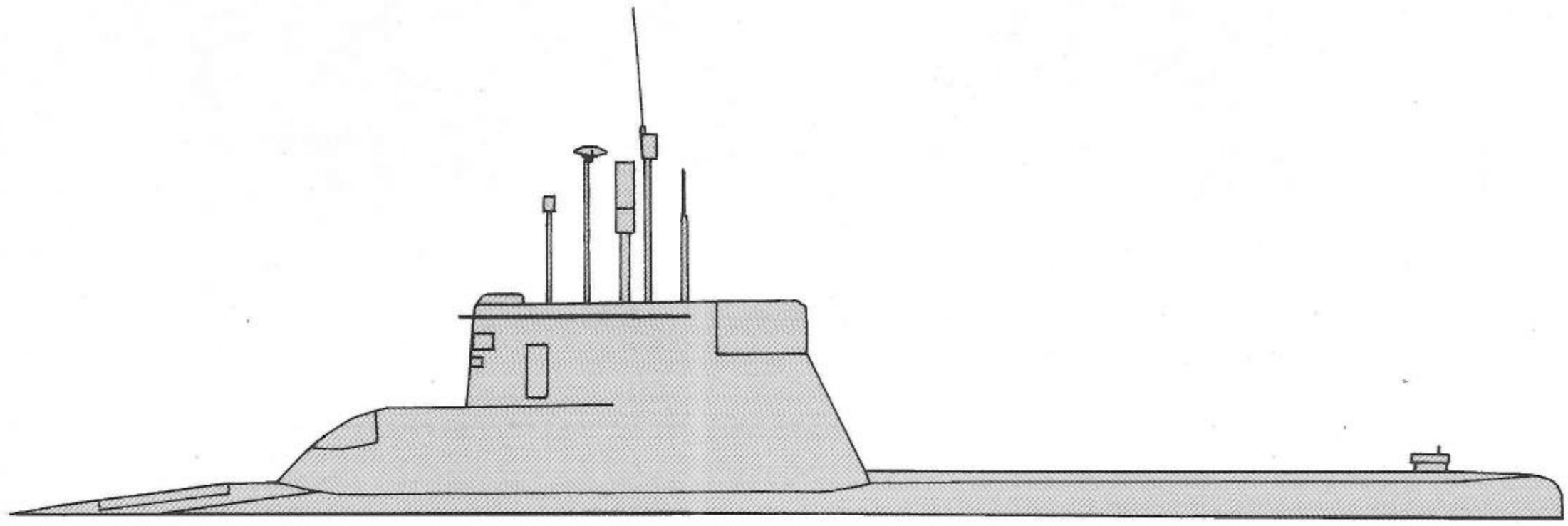
THE FUTURE

The Type 206s will start to be stricken from 2001 onwards, although U 14 may be scrapped earlier, while the Type 206As are currently scheduled to serve 'well into the next century'.



Both sides of the sail showing the various masts. From the front to rear of the sail, these are: national flag on wooden mast; navigation lights; periscope; ESM mast; snort; radar mast (H & L van Ginderen Collection)

MODERNISED KOBBEN



Kobben (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Norway

Class: MODERNISED KOBBEN
Type: 207

Purchased: 15
In service: 6

Displacement:
surfaced: 459 t
submerged: 524 t

Dimensions
Length: 47.4 m (155.5 ft)
Beam: 4.6 m (15 ft)
Draught: 4.3 m (14 ft)

Speed:
surfaced: 12 kts
submerged: 18 kts
Diving depth: 200 m (650 ft)
Range, snorting: 5,000 n miles at 8 kts

Complement: 18 (17 *Svenner*) (5 officers)

SUBMARINES

SKLINNA (S 314 (ex-S 305)

Builder	Rheinstahl-Nordseewerke, Emden, Germany
Laid down	17 Aug 1965
Launched	21 Jan 1966
Commissioned	27 May 1966
Modernisation completed	Jan 1989

SKOLPEN (S 306)

Builder	Rheinstahl-Nordseewerke, Emden, Germany
Laid down	1 Nov 1965
Launched	24 Mar 1966
Commissioned	17 Aug 1966
Modernisation completed	Oct 1989

STORD (S 308)

Builder	Rheinstahl-Nordseewerke, Emden, Germany
Laid down	1 Apr 1966
Launched	2 Sep 1966
Commissioned	14 Feb 1967
Modernisation completed	Aug 1990

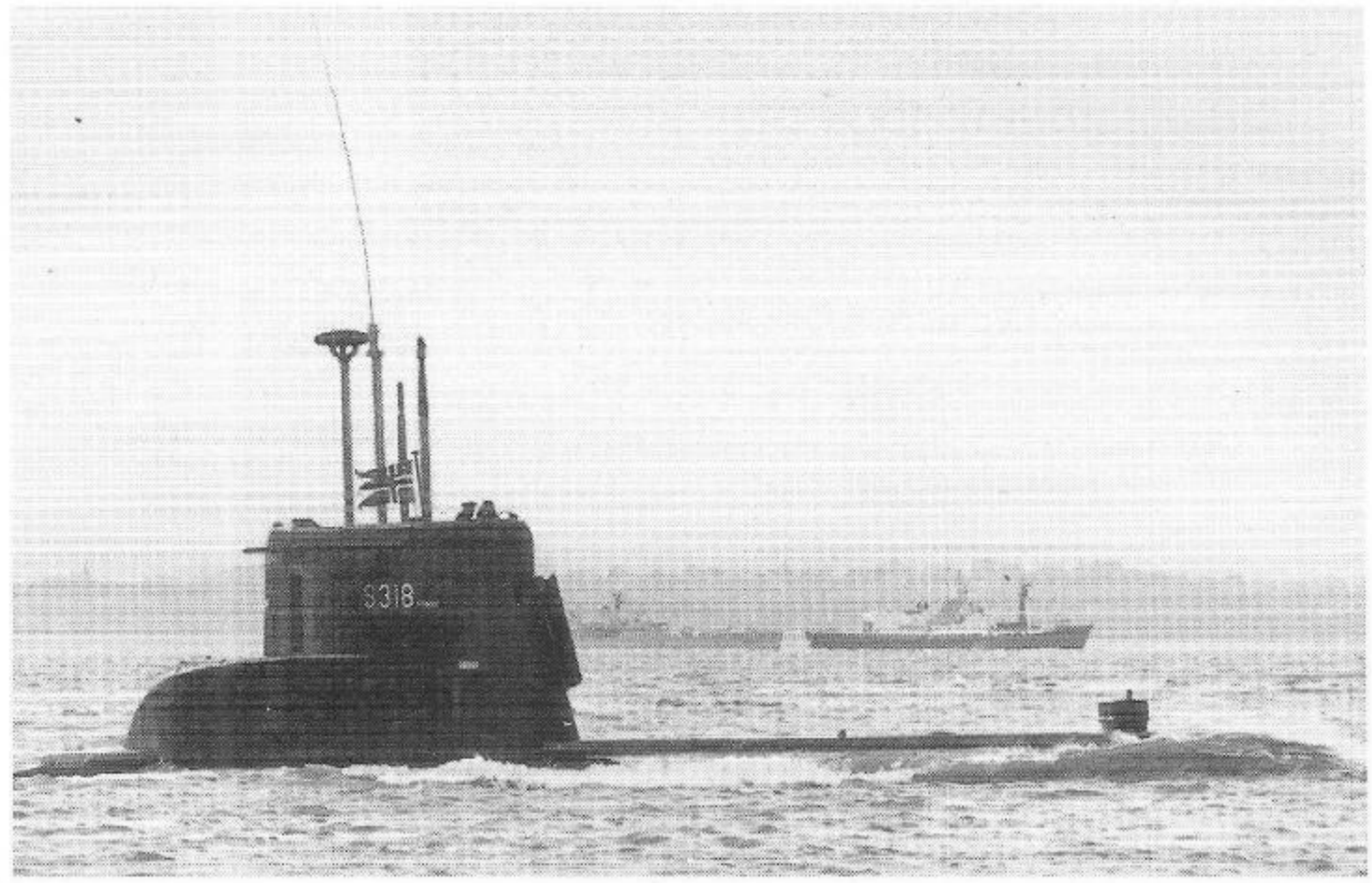
SVENNER (S 309)

Builder	Rheinstahl-Nordseewerke, Emden, Germany
Laid down	8 Sep 1966
Launched	27 Jan 1967
Commissioned	12 Jun 1967
Modernisation completed	Apr 1992

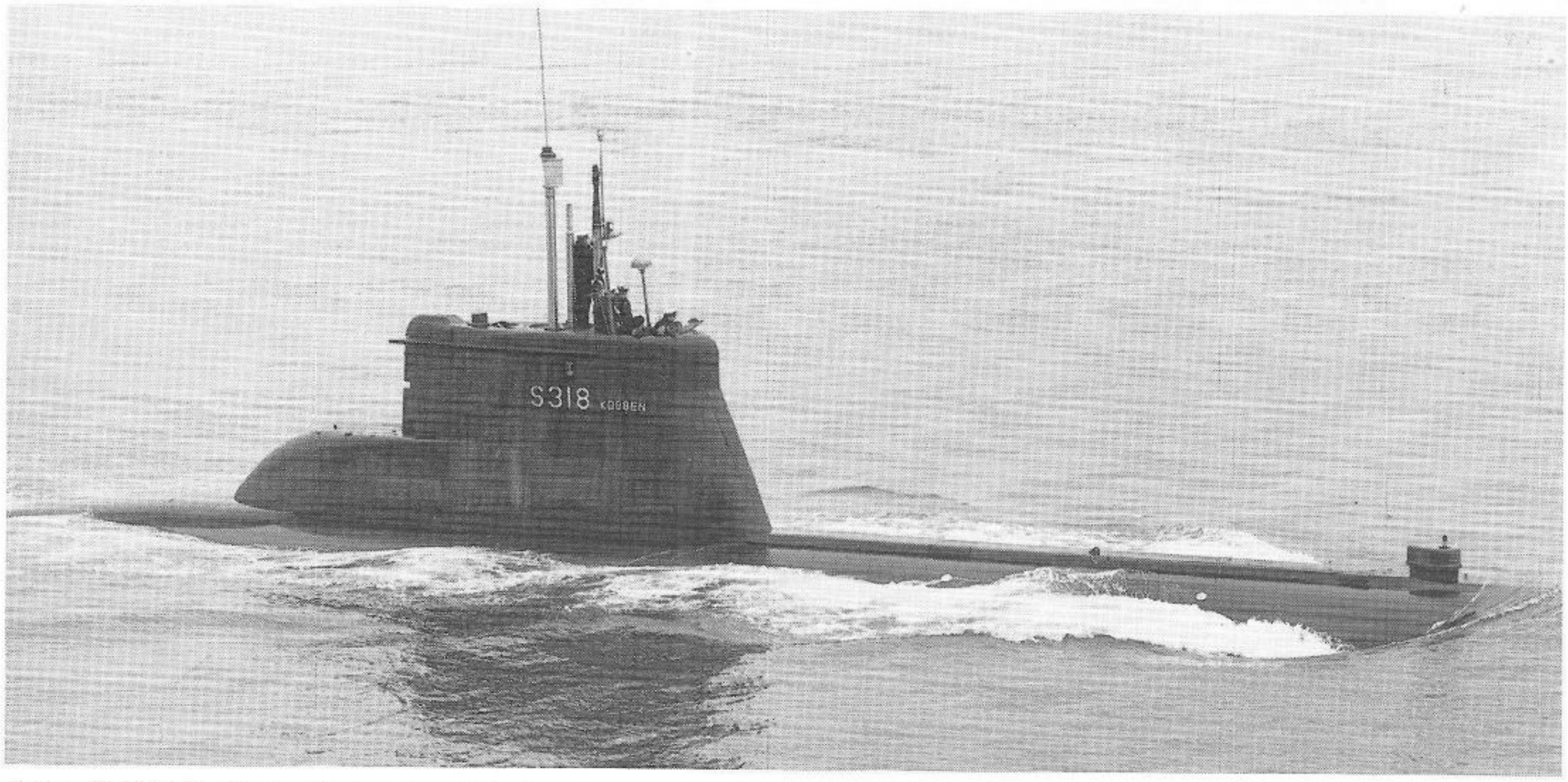
KOBBEN (S 318)

Builder	Rheinstahl-Nordseewerke, Emden, Germany
Laid down	9 Dec 1963
Launched	25 Apr 1964
Commissioned	17 Aug 1964
Modernisation completed	May 1991

Stord *(S 308) one of Norway's six modernised 'Kobben' class submarines* (H & L van Ginderen Collection)



Kobben *(S 318) prior to modification*
(H & L van Ginderen Collection)



Kobben *(S 318) following modification* (Walter Satori)

KUNNA (S 319)
Builder Rheinstahl-Nordseewerke, Emden, Germany
Laid down 3 Mar 1964
Launched 16 Jul 1964
Commissioned 29 Oct 1964
Modernisation completed Dec 1991

WEAPONS SYSTEMS

TUBES

Eight — 533 mm (21 in) bow tubes; swim-out.
Total weapons carried: eight (mix of FFV Type 61, NT37C).

TORPEDOES

Bofors Tp 61

The Tp 61 wire-guided, long-range torpedo was developed by the then FFV company, using high-test peroxide technology bought in from the UK, for use against surface targets.

Specifications
Length: 6.98 m (22.9 ft)
Diameter: 533 mm (21 in)
Weight: 1,860 kg (4,092 lb)
Range: 13.7 n miles (25 km) at 45 kts
Propulsion: HTP
Warhead: 240 kg (528 lb)

Manufacturer/Contractor
Bofors Underwater Systems, Motala, Sweden.

Alliant NT 37

The NT 37 is a dual-purpose 485 mm (19 in) diameter ASW and anti-ship torpedo and is a total redesign of the original US Navy Mk 37 torpedo, the only original element common to both being the torpedo hull. All the internal subsystems, including propulsion, sonar and guidance, have been completely replaced by new hardware and software. Compared to previous models, the new Otto-fuelled, thermochemical propulsion system gives a 40 per cent increase in speed, a 150 per cent increase in range, and an 80 per cent increase in endurance. A solid-state acoustic system and a noise-reduction, laminar-flow nose assembly replace the Mk 37's vacuum-tube acoustic panel and hemispherical nose. A new sonar substantially improves passive detection range against high-speed surface targets and active detection range against small silhouette submarine targets; in most cases, target acquisition range has been doubled. The new self-noise reduction nose assembly increases transducer isolation while reducing flow noise effects, thus reducing the likelihood of self-decoying at all depths.

Specifications
NT 37
Guidance: Wire-guided
Length: 4.5 m (14.76 ft)
Diameter: 485 mm (fits 533 mm launch tubes)
Weight: 750 kg (1,650 lb)
Range: 10.8 n miles (20 km) at 35 kts
Run modes: Straight run/salvo anti-ship; straight run with acoustic miss indicator to initiate acoustic re-attack; active snake and circle — ASW; passive snake and circle — anti-ship
Warhead: 150 kg HE
Fuze: Contact and proximity
Propulsion: Thermochemical rotary piston cam engine with Otto fuel

Manufacturer/Contractor
Alliant Techsystems, Marine Systems, Hopkins, Minnesota, USA.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

There is an ARGOSystems radar warning set.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Kongsberg MSI-90(U) torpedo fire-control system

MSI-90U was designed to meet the requirements of the new generation of Norwegian and German submarines, the 'Ula' and 'Type 212' classes, but has also been fitted in the 'Kobben' class during its mid-life modernisations. MSI-90U is a software-based command and weapons control system, using distributed processing, a high-capacity serial data transmission system (LAN), and multifunction operator consoles.

The system uses distributed data processing employing the 32-bit KS-900 general purpose computer, which is designed for real-time processing, based on the commonly used Motorola 68000/68020 range of microprocessors. KS-900 can be programmed in Ada, C and Pascal.

The LAN, named BUDOS, uses standardised interfaces which comply with NATO STANAG 4156, but other standard interfaces such as RS-422 are also available. Any subsystem can communicate with any other BUDOS-connected subsystem and new subsystems can easily be added by means of spare interfaces on the existing BUDOS multiplexers, or by adding more multiplexers.

There are four multifunction operator consoles (each with its own KS-900 computer), three main KS-900 computers and two or three KS-900 weapon computers (depending on weapon type and customer requirements).

The system is designed to carry out sensor integration covering target-motion analysis, classification and identification, and weapons assignment and control. A number of supplementary facilities is also provided, such as tactical evaluation and navigation, threat evaluation, engagement analysis, preprogrammed movements, sound trajectory calculations and presentations, predicted sonar ranges for 'own ship' and

hostile ships, presentation of geographical fixed points and areas, data recording, and simulation for training purposes and so on.

Manufacturer/Contractor
Kongsberg, N-3601 Kongsberg, Norway.

RADAR

Kelvin Hughes Type 1007
The Kelvin Hughes Type 1007, mounted on its own mast, provides the major input to the internal workstations and the navigation plot.

Specifications
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW

Antenna gain: 31 dB
Pulsewidth: 0.08/0.35/0.8 µs
Pulse repetition frequency: 1,600/800/400 pps
Scan rate: 26 rpm

Manufacturer/Contractor
Kelvin Hughes, Ilford, Essex, UK.

SONAR

STN Atlas CSU-83/1
The CSU-83 (DBQS-21) sonar suite is designed for submarines of 400 tonnes displacement and upwards, and is the primary sensor of the submarine fire-control and command system of the German Navy. It comprises a passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array covering the frequencies 10 Hz to 2 kHz, a towed array, and two self-noise detectors. The system is claimed to provide high probability of detection over 360°.

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

PERISCOPES

Pilkington Optronics CK 30 search periscope.

Manufacturer/Contractor
Pilkington Optronics, St Asaph, Clywd, UK.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 MTU 12V 493 AZ80 GA31L diesels; 880 kW (1,200 hp(m)) sustained
Electric motor: 1–1.32 MW (1,800 hp(m)) sustained
Shaft: 1

FURTHER INFORMATION

PROGRAMME

When the programme to build these submarines was announced, it was stated that the USA and Norway would share the costs equally. The submarines were delivered to Norway between 1964 and 1967, but in order to help with the preparation of its crews for the new class, the Bundesmarine lent U 4 to the Norwegian Navy from 1962 to 1964, which was similar in most respects to the new class. It was commissioned into the Norwegian Navy as *Kobben* (S 310) and flew the Norwegian ensign, but was returned to the German Navy at the end of the loan period, where it resumed its previous number. A later boat was commissioned as *Kobben* (S 318), the name having an historical significance for Norway, as it was the name of the navy's first submarine, which was launched on 5 May 1909, also at Germaniawerft, Kiel, Germany.

DESIGN

The design is based on that of the IKL Type 205, which was built for the German Navy as the 'U 1' class, but with a stronger hull to give increased diving depth. It should be noted that there are no reloads for the eight torpedo tubes.

TRAINING BOAT

Svenner (S 309) was built as a training boat for officers. To meet the requirements of this role, it is 1 m longer, has a lengthened second periscope, and displaces an additional 14 t.

MODERNISATION

The six submarines still serving with the Norwegian Navy were all modernised at the Urivale Shipyard, Bergen. The work included lengthening the hull by 2 m to accommodate new engines, and new communications, navigation and fire-control equipment were all fitted.

DISPOSALS

The first to be discarded was *Kinn* (S 316) which was stricken in 1982. Another four were to have been stricken in 1991, but one was transferred to Denmark to replace *Stadt* (S 307), which had been damaged beyond repair. A second boat, *Ula* (S 300), was reclaimed by the US Navy under the rarely invoked procedures for offering back equipment bought with US funds, where it was subsequently used for a variety of trials.

Three boats, *Utvaer* (S 303), *Uthaug* (S 304) and *Kya* (S 317) were sold to Denmark in 1989-91, and a further boat, *Kaura* (S 315), was transferred to Denmark to serve as a source of spares in the repairs of *Saelen* (the former Norwegian Uthaug), which had been flooded.

The position is summarised in the table below:

Name	Pennant No	Commissioned	Remarks	Situation: 1 Jan 1997
Ula	S 300	17 May 1965	Returned to US custody May 1991	-
Utsira	S 301	1 Jul 1965	Stricken 1991	-
Utstein	S 302	9 Aug 1965	Stricken 1991	-
Utvaer	S 303	1 Dec 1965	Transferred to Denmark, 1989	Danish *Tumleren* (S 322)
Uthaug	S 304	16 Feb 1966	Transferred to Denmark, 1990	Danish *Saelen* (S 323)
Sklinna	S 305	17 Aug 1966	Renumbered 1988, but retained name	Norwegian *Sklinna* (S 314)
Skolpen	S 306	17 Aug 1966		Norwegian *Skolpen* (S 306)
Stadt	S 307	15 Nov 1966	Was to have transferred to Denmark, but damaged and stricken 1987	-
Stord	S 308	9 Feb 1967		Norwegian *Stord* (S 308)
Svenner	S 309	1 Jul 1967		Norwegian *Svenner* (S 309)
Kobben	S 310		German U 4 lent to Norway for training 1962-64; returned to FGN and BU 1967	-
Kaura	S 315	5 Feb 1965	Transferred to Denmark Oct 1991 for use as spares	-
Kinn	S 316	8 Apr 1964	Stricken 1982	-
Kya	S 317	15 Jun 1964	Transferred to Denmark 1991 to replace stricken Stadt	Danish *Springeren* (S 324)
Kobben	S 318	17 Aug 1964		Norwegian *Kobben* (S 318)
Kunna	S 319	1 Oct 1964		Norwegian *Kunna* (S 319)

TUMLEREN

GENERAL SPECIFICATIONS

Country: Denmark

Class: TUMLEREN
Type: Modified Norwegian Kobben (German Type 207)

Bought: 3
In service: 3

Displacement:
surfaced: 459 t
submerged: 524 t

Dimensions
Length: 47.4 m (155.5 ft)
Beam: 4.6 m (15 ft)
Draught: 4.3 m (14 ft)

Speed:
surfaced: 12 kts
submerged: 18 kts
Diving depth: 200 m (650 ft)
Range, snorting: 5,000 n miles at 8 kts

Complement: 18 (5 officers)

SUBMARINES

TUMLEREN (S 322)

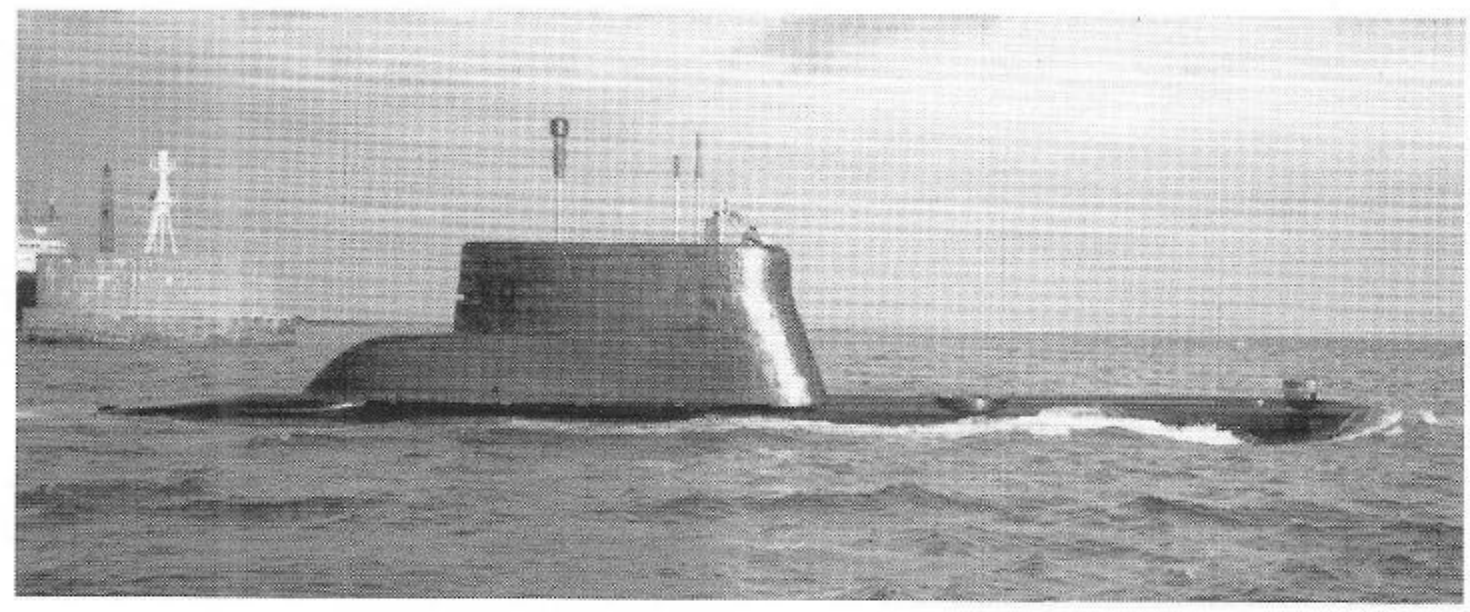
Builder	Rheinstahl-Nordseewerke, Emden, Germany
Laid down	24 March 1965
Launched	30 July 1965
Commissioned, Norwegian Navy, Utvaer (S 303)	1 Dec 1965
Modernised	1987-89
Commissioned, Danish Navy	20 Oct 1989

SAELEN (S 323)

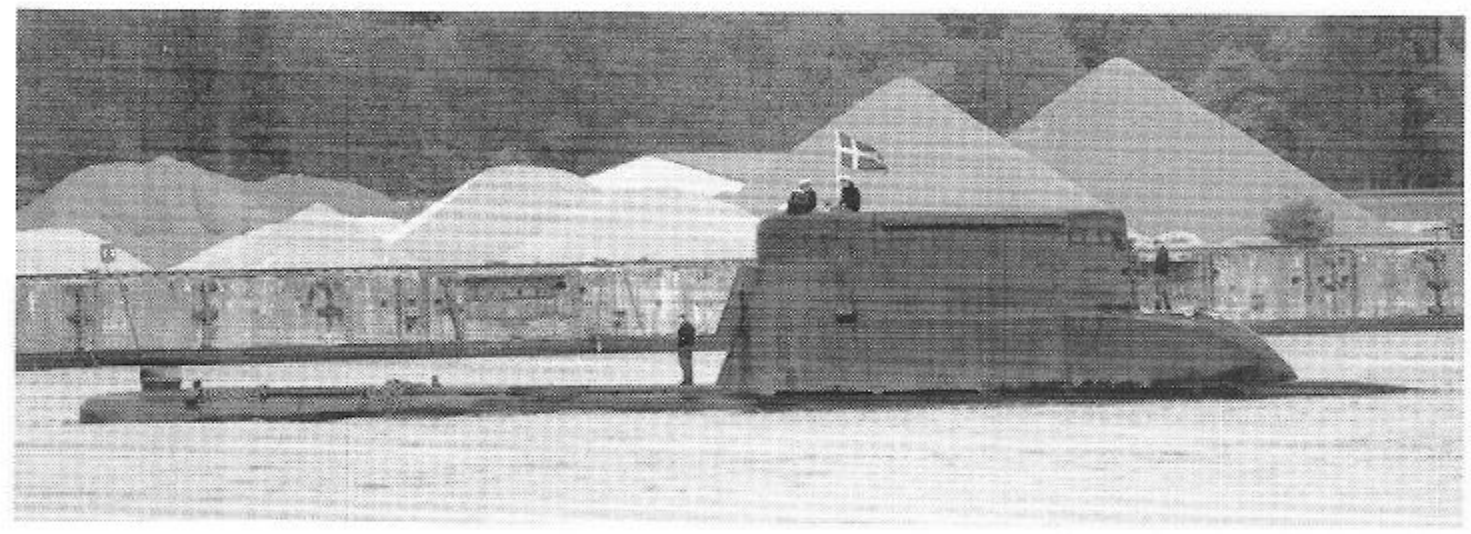
Builder	Rheinstahl-Nordseewerke, Emden, Germany
Laid down	31 May 1965
Launched	3 Oct 1965
Commissioned, Norwegian Navy, Uthaeg (S 304)	16 Feb 1966
Modernised	1988-90
Commissioned, Danish Navy	5 Oct 1990

SPRINGEREN (S 324)

Builder	Rheinstahl-Nordseewerke, Emden, Germany
Laid down	26 May 1963
Launched	20 Feb 1964
Commissioned, Norwegian Navy, Kya (S 317)	15 Jan 1964
Modernised	1989-91
Commissioned	10 Oct 1991



Danish Navy 'Tumleren' class submarine. The large ESM dome on the after mast is the antenna for Racal Sealion (Racal)



Tumleren *(S 322), nameship of the class of three* (H & L van Ginderen Collection)

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) bow tubes.
Total weapon load, eight (no reloads).

TORPEDOES

Bofors Tp 61

The Tp 61 wire-guided, long-range torpedo was developed by the then FFV company, using high-test peroxide technology bought in from the UK, for use against surface targets.

Specifications
Length: 6.98 m (22.90 ft)
Diameter: 533 mm (21 in)
Weight: 1,860 kg (4,100 lb)
Range: 13.7 n miles (25 km) at 45 kts
Propulsion: HTP (hight-test peroxide)
Warhead: 240 kg (530 lb)

Manufacturer/Contractor
Bofors Underwater Systems, Motala, Sweden.

ELECTRONIC WARFARE SYSTEMS

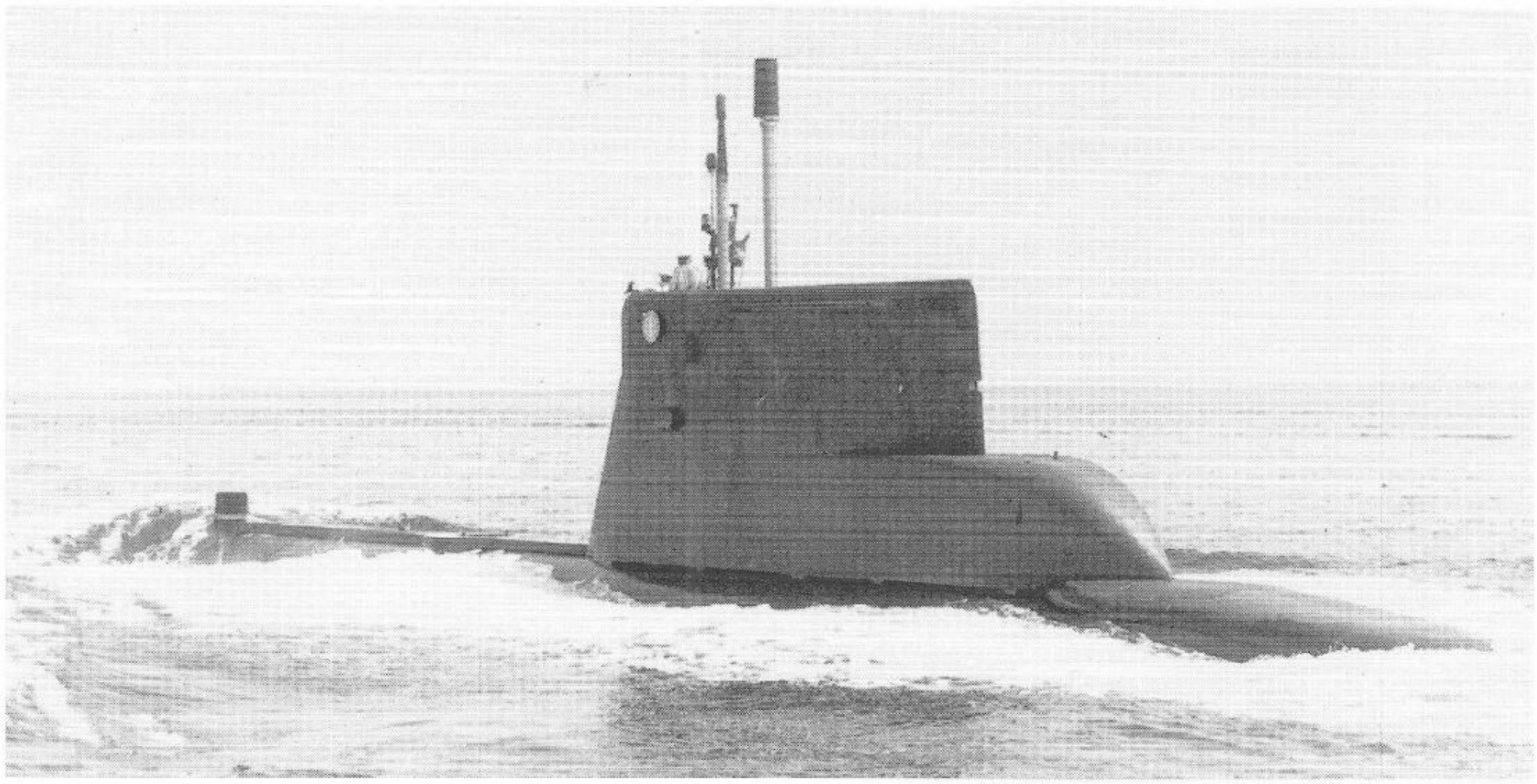
ELECTRONIC SUPPORT MEASURES (ESM)

Racal Sealion

Sealion is a submarine ESM system designed to provide radar warning and a high-accuracy bearing search capability over the frequency range 0.5 to 18 GHz. It is wide open in bearing and frequency and offers a near 100 per cent probability of intercept. It uses an omnidirectional antenna array and a rotating antenna. The antennas are separate units and may be mounted on separate masts. The omnidirectional antennas provide signals for measurement of amplitude, pulsewidth, frequency and time of arrival of received radar pulses. Processing of this data, together with identification of the radar through the system library, provides the warning function of the ESM system. The rotating dish provides signals for direction-finding for passive targeting and surveillance.

Specifications
Frequency range: 0.5-18 GHz
DF accuracy: 1° RMS
Sensitivity: −60 dBm
Dynamic range: 55 dB
Library: Up to 3,000 emitter modes

Manufacturer/Contractor
Racal Radar Defence Systems, Chessington, UK.



'Tumleren' class submarine (Danish Navy)

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Terma Sub-TDS

The Terma Submarine Tactical Data System (Sub-TDS) is designed to meet the requirements of combat information systems for small submarines. Its functions include: picture compilation, situation assessment, tactical manoeuvre calculations and weapons deployment. It provides a standard tactical datalink to exchange track and ESM information as well as plain text messages, utilising existing onboard radio equipment, but may also be supplied with NATO Link 11 or other customer-specified datalink. The Sub-TDS supports the Terma Torpedo Fire-Control System (TFCS), which has its own processor cabinet and torpedo control panels. The system provides control of up to four wire-guided torpedoes simultaneously. It handles readiness status reports from the tubes and torpedoes, and controls run-up and firing as well as course and depth guidance when under way. The TFCS also supports fire control solutions for straight running torpedoes.

Manufacturer/Contractor
Terma Elektronik AS, Lystrup.

RADAR

These submarines are fitted with a Terma Skanter surface search radar.

Specifications
Band: I/J-bands
Horizontal beamwidth: <2°
Vertical beamwidth: 20 ±1°
Gain: 28.5 dB
Scan rate: <30 rpm

Manufacturer/Contractor
Terma Elektronic, Lystrup, Denmark.

SONAR

STN Atlas PSU-83

The PSU-83 passive sonar suite is designed for small- and medium-size submarines and uses a newly developed programmable and north-stabilised beamformer which can handle all types of hydrophone arrays. In the 'Tumleren' class, the PSU-83 uses a conformal array in the bow and an aft-looking array in the 'bustle' at the base of the sail. There is a single operator position.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen, Germany.

PERISCOPES

Search periscope

Pilkington Optronics CK 34.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 MTU 12V 493 AZ80 diesels; 880 kW (1,200 hp(m))

Electric motor: 1 Siemens; 1.25 MW (1,700 hp(m))
Shaft: 1

FURTHER INFORMATION

PROGRAMME

The Norwegian Navy bought 15 Type 207s (see Kobben entry above) in the late 1960s. In the mid-1960s the Danish submarine force was becoming distinctly obsolete with three Danish-designed and -built 'Delfinen' class at the end of their useful lives, which left just two 'Narvhalen' class. In order to plug the gap while plans could be made for the long-term future, it was decided to buy three surplus Norwegian 'Kobben' class boats, which, like the Danish Narvhalens, were derivatives of the Type 205. The first two were acquired from Norway in 1986 for modernisation and the third in late 1989, and all three were modernised before being commissioned into the Danish Navy.

The programme has not been uneventful. As described in the Norwegian Kobben entry, *Stadt,* having been earmarked for sale was then run aground and so severely damaged that it had to be stricken and replaced by another boat. Then at the end of the modernisation work *Saelen* was being towed unmanned to Denmark when it sank. It was recovered but the Norwegian *Kaera* (S 315) had to be bought to be used as a source of spares for the repair work.

MODERNISATION

The modernisation programme was carried out at Urivale Shipyard, Bergen between 1987 and 1991. The work included lengthening by 1.6 m (5.2 ft), which increased displacement, as well as new communications, ESM, navigation and fire-control equipment. New sonar equipment was installed in 1992/93 in a follow-up programme.

TYPE 209

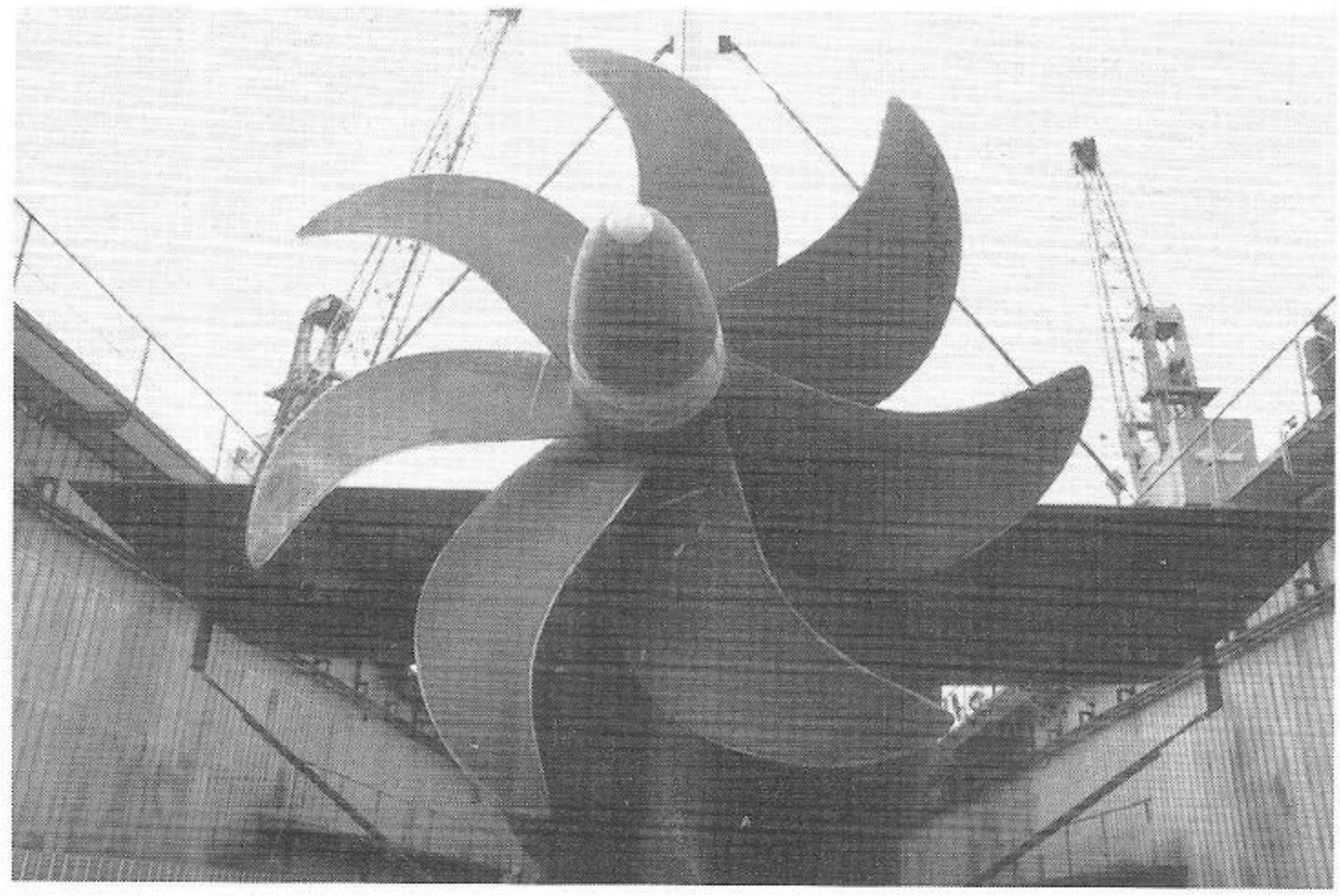
OVERVIEW

The Type 209 is a good example of a proper market analysis leading to a product which will sell well, even in a highly competitive market. The first Type 209, the Greek Navy's *Glavkos,* was commissioned on 6 September 1971 and since then more than 50 have been sold to 14 navies, with more orders in the pipeline, and Type 209s are currently being constructed in Germany, Brazil, South Korea and Turkey.

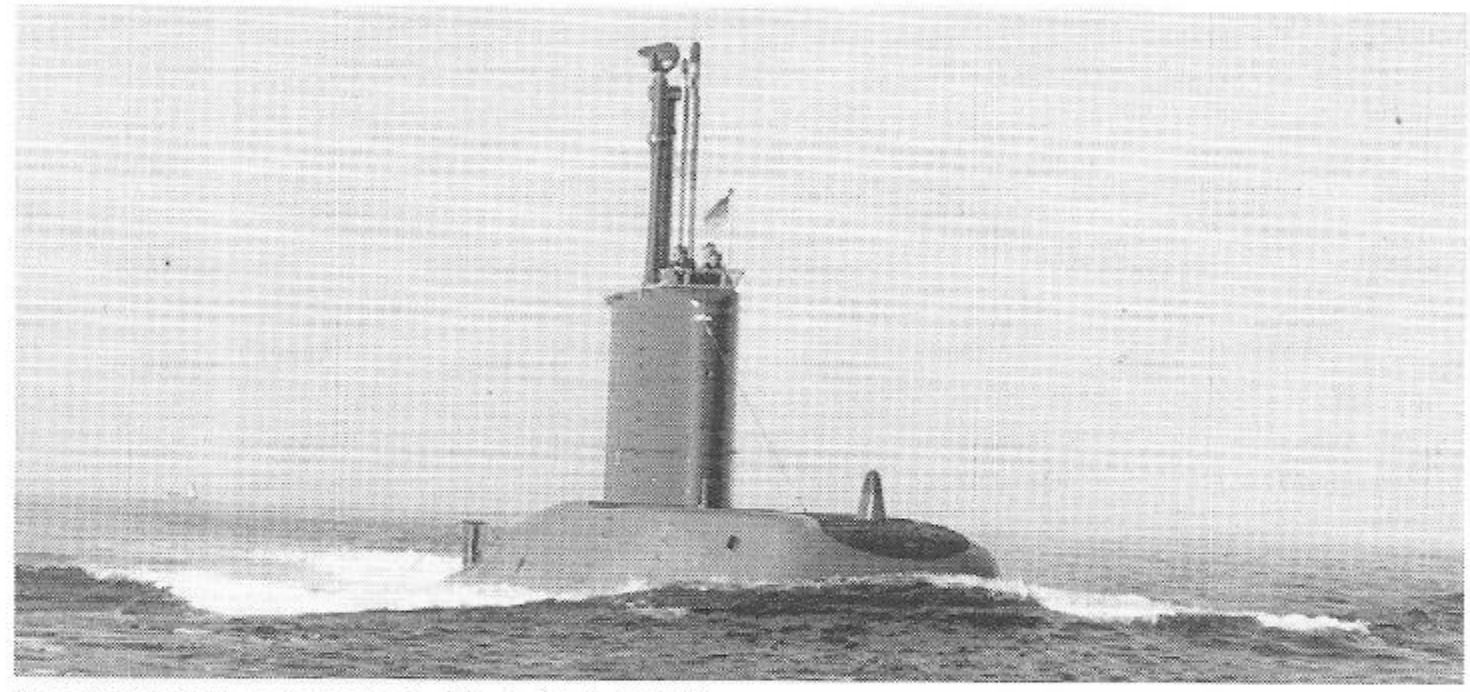
The original Type 209 appeared on the international scene in the late 1960s, at a time when existing submarine operators were beginning to find that the many second-hand US and British World War Two submarines were in need of replacement. In addition, a number of other navies wanted to start operating submarines for the first time. At that time the few new Western diesel-electric submarine designs on the market were not only large and expensive both to buy and to operate, but had, in essence, been designed for the NATO/Warsaw Pact confrontation and made few (if any) concessions to export requirements. Soviet submarines were, of course, simpler, cheaper and available, but many of those seeking submarines did not wish to purchase equipment from the USSR. For such navies, the Type 209 provided a good solution: a powerful weapons system, at a reasonable price, and with seventy years of German submarine experience behind it. An additional factor has been the clear customer satisfaction, with numerous navies placing repeat orders.

The Type 209 has demonstrated a number of strong selling points. First, its good hull design and the acoustic isolation of internal components make it difficult to detect, as was demonstrated by the searches made by the British task force for the Argentine *San Luis* during the Falklands (Malvinas) war in 1982. Second, good performance, with long endurance, coupled with a high sprint speed: 22 knots for one hour. Third, good weapon load, consisting of 14 torpedoes (eight in tubes plus six reloads) and the ability to be adapted to take Sub-Harpoon missiles. Fourth, is the demonstrated willingness of HDW to transfer technology overseas and to help customers to establish their own submarine construction capability, which has happened in Argentina, Brazil, India, South Korea and Turkey. Finally, there is a demonstrated record of success, with 54 Type 209s sold over a period of 20 years to 12 navies and without a single operational loss.

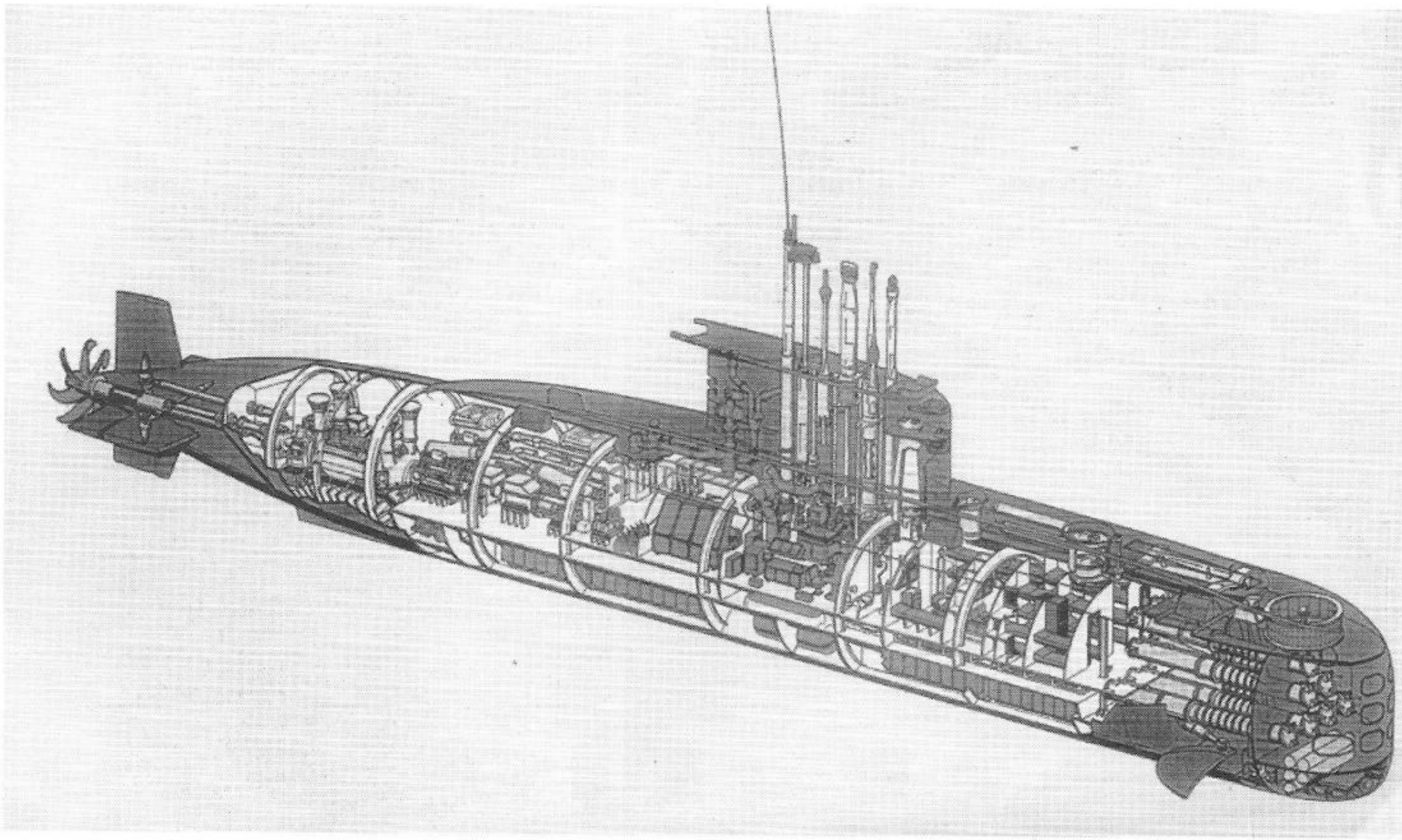
The Type 209 has been progressively developed



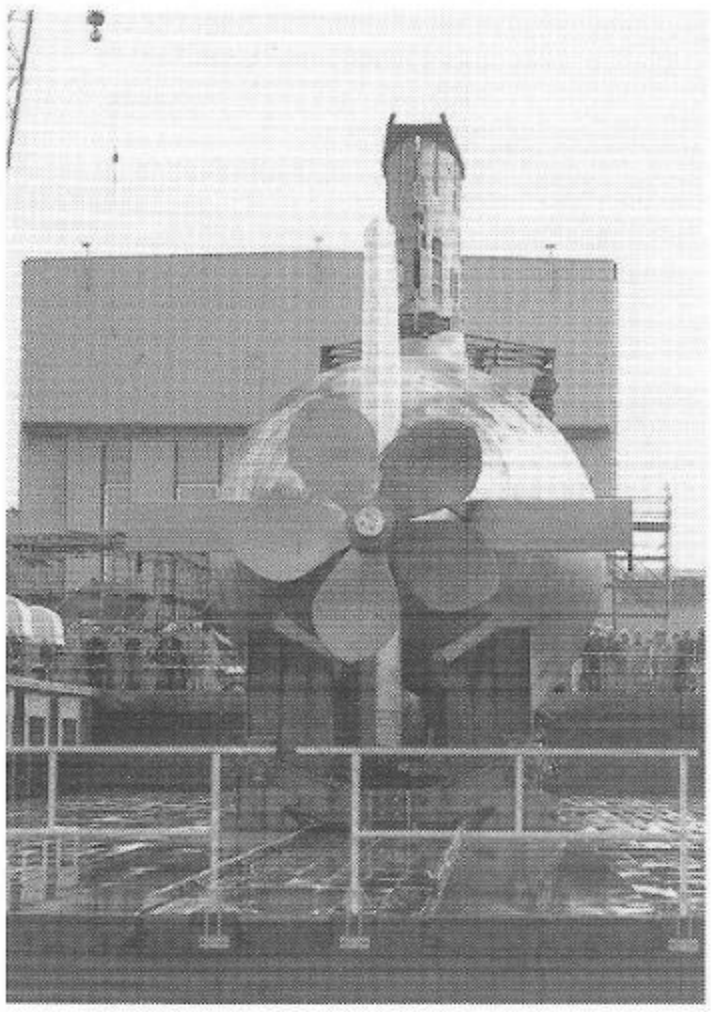
The latest seven-bladed, skewed propeller (HDW)



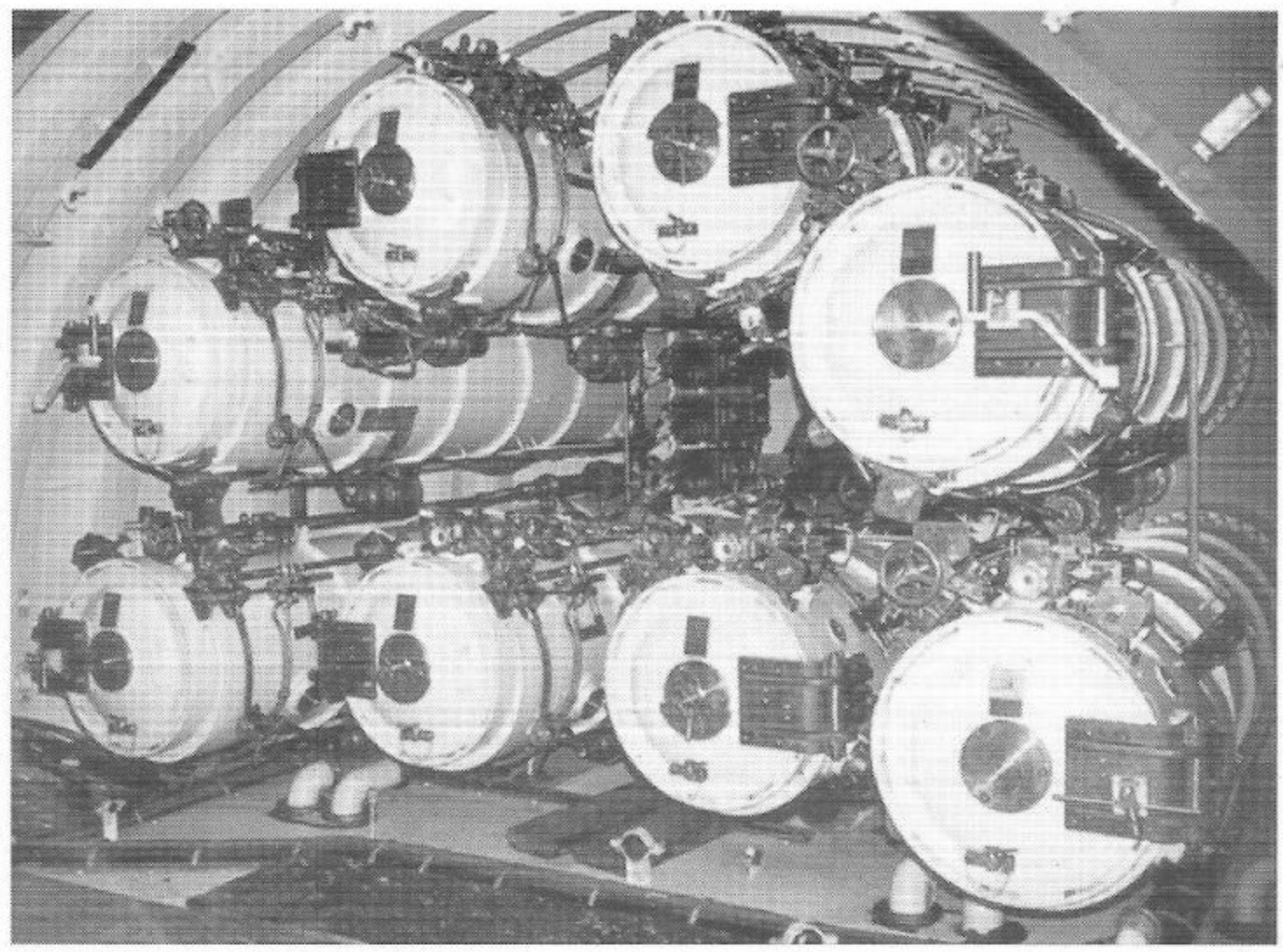
Type 209/1500 undergoing builder's trials (HDW)



Type 209 (HDW)



Type 209 with the original five-bladed propeller (HDW)



Torpedo tubes (HDW)

over the years and further sales are likely. In 1995, during their latest round of defence talks with the USA, the Republic of China (Taiwan) asked for three Type 209s to be built by Ingalls, but this proved to be the only major request to be turned down. A similar project, for Ingalls to build two Type 209s for the Egyptian Navy, has received political approval but is being held up indefinitely by financial problems, the cost of the programme for two boats reported to be of the order of $800 million.

DESIGN

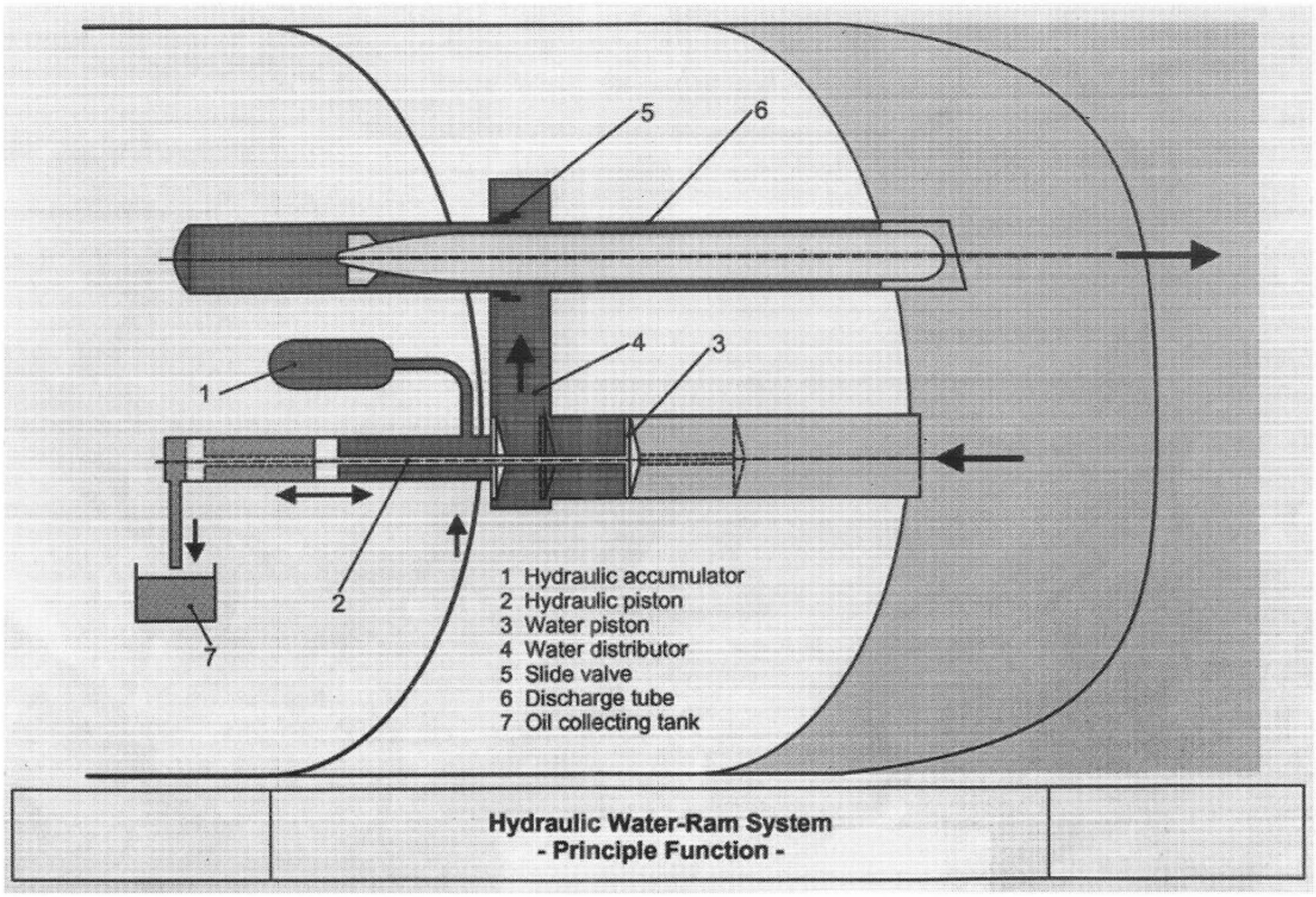
The Type 209 is a single-hull design with two main ballast tanks, and forward and after trim tanks. Forward and after ends are free-flooding, as is the sail. Earlier Type 209s had a five-bladed propeller, but the latest versions have a large diameter, seven-bladed, skew-back propeller, made of Sonostone bronze, and its slow rate of revolution, allied to the low propeller load results in a highly efficient propulsion system.

Type 209 is constructed of HY 80 steel, which can be detected by ASW aircraft fitted with MAD sensors. There is an option available to construct the Type 209 of non-magnetic steel as used in the German Navy's Type 206 submarines and Type 343 MCMVs, but, as far as is known, no export customers have yet availed themselves of this option.

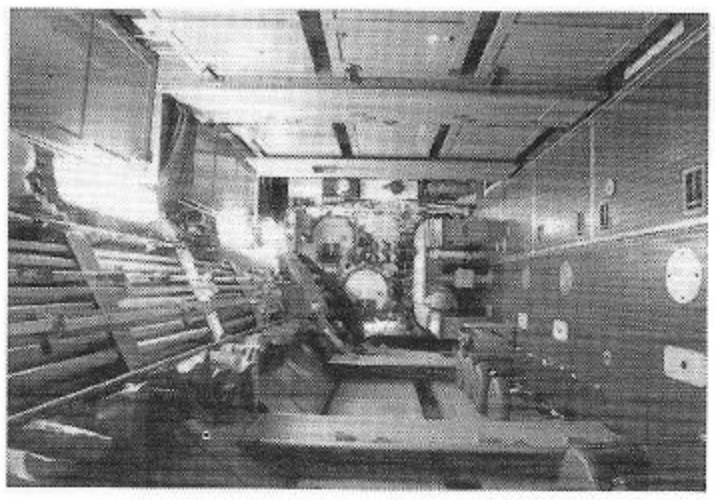
There are four diesel generators, where virtually all other diesel-electric submarines, even the larger ones, have only two. The original engine was the MTU 493-V12, but recent boats and refits are using the MTU 396-V8, which has lower specific fuel consumption, reduced noise levels and greater time between overhauls. Another recent change is from rotary to static power converters, the latter being inherently quieter.

There are four batteries of 120 cells each, with a full battery-cooling system. As far as possible ballast has been converted into battery capacity, the battery weight in some versions exceeding 20 per cent of that of the entire submarine. This battery capacity enables the Type 209 to have a cruising range of some 400 n miles between two snorting periods, based on a speed of 4 knots and 80 per cent battery discharge, and the total cruising range is more than 12,000 n miles at 4 knots submerged with provisions for 50 days.

Two air-independent propulsion (AIP) options are now on offer, both of which would require a plug-in section some 6 m (19.7 ft) long to be inserted immediately abaft the sail. The systems use either fuel cells or



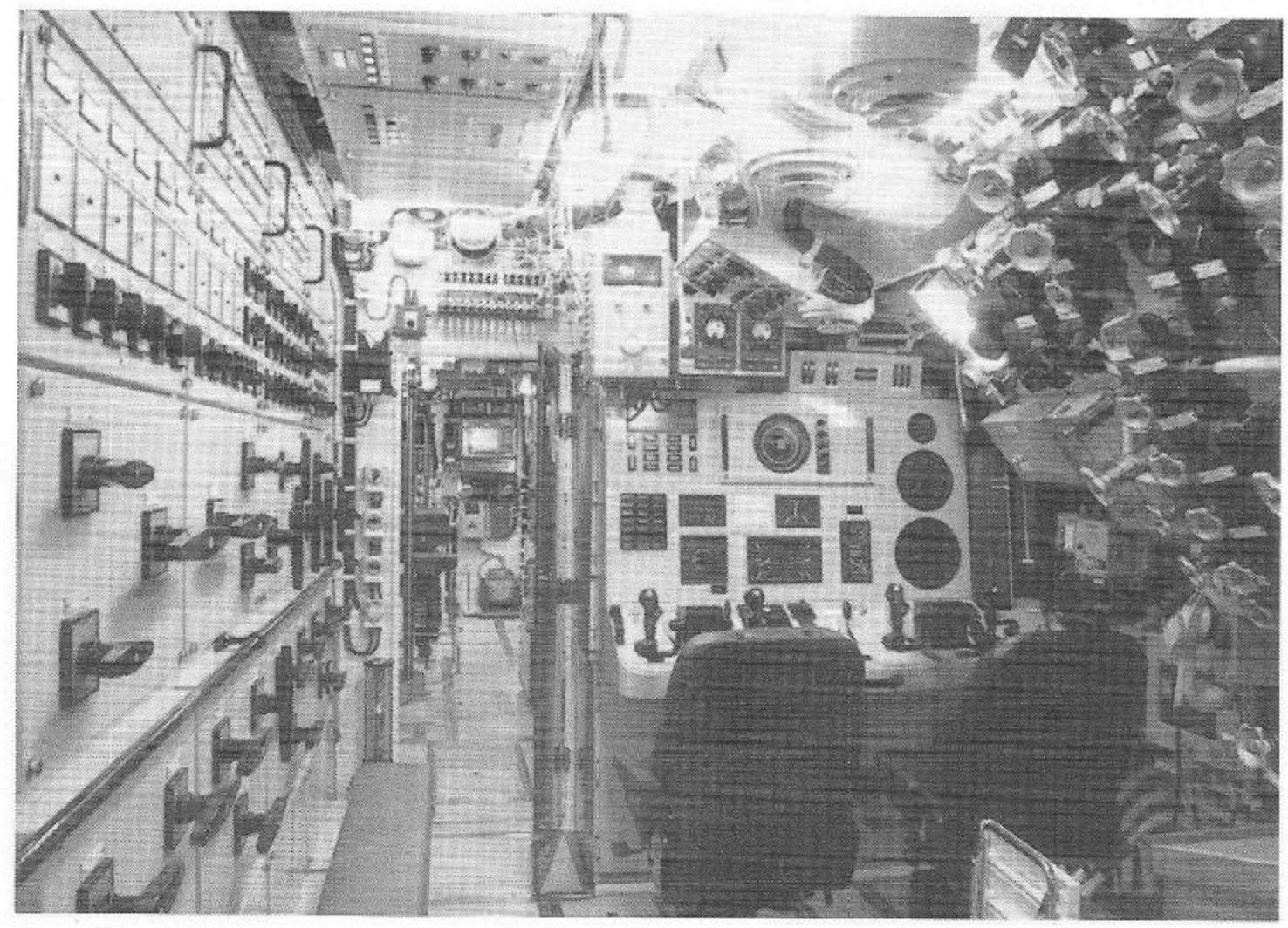
Swim-out tubes (HDW)



Type 209 — crew accommodation, looking forward (HDW)

TABLE 1: TYPE 209 — SUMMARY

Type	Country	Number	Commissioned
209/1100	Greece	3	1971-72
	TOTAL	**3**	
209/1200	Argentina	2	1974
	Peru	6	1974-83
	Colombia	2	1975
	Turkey	6	1976-90
	Greece	5	1979-80
	Korea, South	9	1993-97
	TOTAL	**30**	
209/1300	Venezuela	2	1976-77
	Ecuador	2	1977-78
	Indonesia	2	1981
	Chile	2	1984
	TOTAL	**8**	
209/1400	Brazil	4	1989-99
	Turkey	4	1994-99
	TOTAL	**8**	
209/1500	India	4	1986-94
	TOTAL	**4**	
	GRAND TOTAL	**53**	



Type 209 — helm and depth controls (HDW)

closed-cycle diesels, both with liquid oxygen for the reaction process.

The sensor fit is a matter for the customer although HDW has well-established relationships with certain suppliers who have optimised their products for use in the Type 209. Such 'standard' suppliers are by no means confined to German firms, such as Siemens and STN Atlas, but also include Thomson-CSF, Signaal and Racal. The Type 209 has a snorkel, two periscopes and various penetrating and non-penetrating hoistable masts for different sensors and antennas.

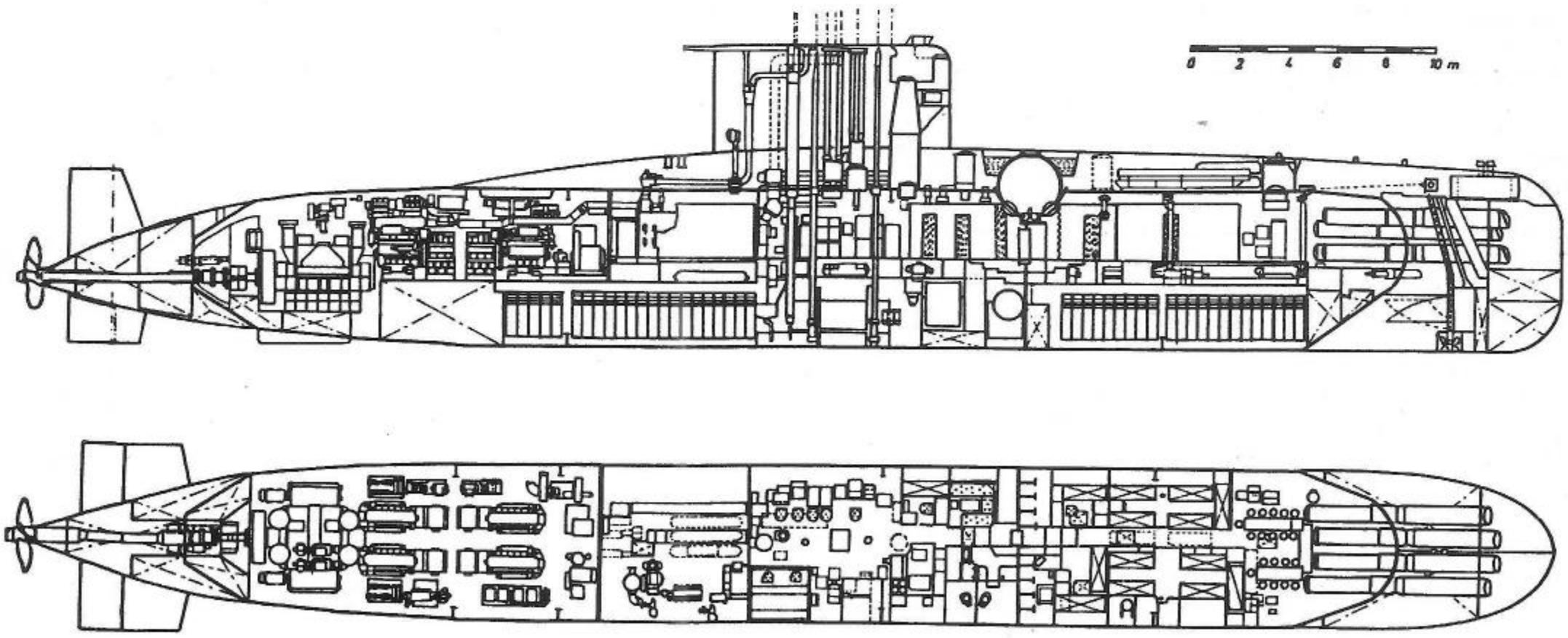
There are eight torpedo tubes arranged in a horizontal row of four, with another four in an arc above:

The tubes, originally made by Krupp MaK Maschinenbau but now produced by Howaldtswerke, are slightly oversized to enable the torpedoes to 'swim-out' using their motors alone to drive them out of the tube, with the torpedoes kept on course within the tube by guide rails. This system results in a tube that is simpler, lighter and cheaper than a conventional 'impulse tube' and can be used at all depths.

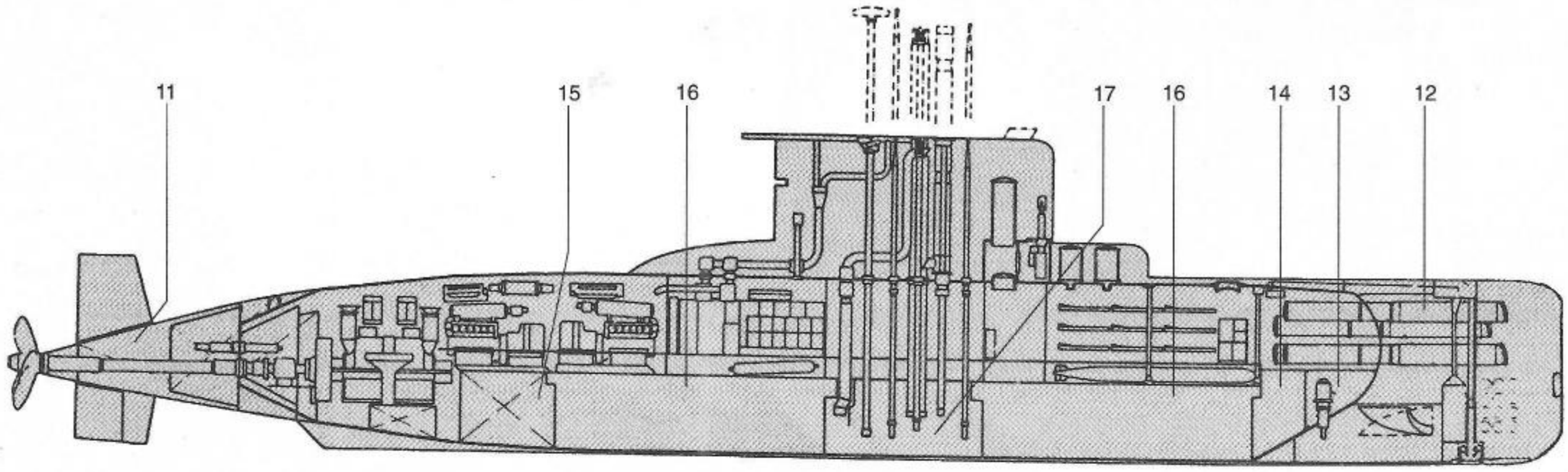
Up to four of the swim-out tubes can be modified during routine docking into positive-discharge tubes to enable them to handle Sub-Harpoon, which can then be launched at any depth. This involves fitting a ring inside the tube to form a gastight seal around the missile capsule; compressed air at 120 bar is then used to expel the capsule from the tube. The air comes from a bottle, which is recharged between shots from the submarine's air supply.

The expected life is estimated to be in excess of 30 years. The oldest boats, the Greek 'Glavkos' class, are, for example, currently undergoing substantial refits which will give them a life well past their thirtieth anniversary which occurs in 2001.

There are five basic models, the Types 1100, 1200, 1300, 1400 and 1500, the figure denoting the submerged displacement. In essence, as is shown in Table 2, the extra size is obtained by stretching the pressure hull, to enable extra fuel or additional sensors to be carried, or, in the case of the Type 1500, a Gabler rescue sphere, the only such system installed in any Western submarine.



Type 1500 (IKL)



Type 209/1200 (HDW)
1 *Engine room* **2** *Engine control room* **3** *Operations centre* **4** *Communications room* **5** *Sick bay* **6** *Commanding Officer's cabin* **7** *Galley* **8** *Officers' living quarters* **9** *NCOs' living quarters* **10** *Enlisted men's living quarters* **11** *Aft diving room* **12** *Forward diving room* **13** *Steering unit* **14** *Torpedo tubes* **15** *Fuel tanks* **16** *Battery tanks* **17** *Periscope well*

TABLE 2: TYPE 209 — SUMMARY OF MAJOR CHARACTERISTICS

Type (Example)	Type 209/1100 (Greece)	Type 209/1200 (Argentina)	Type 209/1300 (Chile)	Type 209/1400 (Brazil)	Type 209/1500 (India)
Displacement					
surfaced	1,100 t	1,248 t	1,260 t	1,260 t	1,600 t
submerged	1,207 t	1,440 t	1,390 t	1,440 t	1,850 t
Dimensions					
length	54.10 m (177.5 ft)	55.9 m (183.4 ft)	59.5 m (195.2 ft)	61.0 m (200.1 ft)	64.4 m (211.2 ft)
beam	6.2 m (20.34 ft)	6.3 m (20.5 ft)	6.2 m (20.3 ft)	6.2 m (20.3 ft)	6.5 m (21.3 ft)
draught	5.9 m (19.4 ft)	5.5 m (18 ft)	5.5 m (18 ft)	5.5 m (18 ft)	6.0 m (19.7 ft)
Speed					
surfaced	11.5 kts	10 kts	11 kts	11 kts	11 kts
snorting	—	11 kts	—	11 kts	—
submerged	22 kts	22 kts	21.5 kts		
Range					
surfaced	—	6,000 n miles/8 kts	8,200 n miles/8 kts	8,200 n miles/8 kts	13,000 n miles/10 kts
snorting	8,600 n miles/4 kts	—	—	—	8,000 n miles/ 8 kts
submerged	230 n miles/8 kts 25 n miles/20 kts	230 n miles/8 kts 400 n miles/4 kts	400 n miles/ 4 kts 16 n miles/21.5 kts	400 n miles/4 kts	—
Diving depth	250 m (820 ft)	250 m (820 ft)		250 m (820 ft)	260 m (853 ft)
Complement	31	34	32	30	40

SALTA

GENERAL SPECIFICATIONS

Country: Argentina

Class: SALTA
Type: 209/1200

Built: 2
Active: 2

Displacement:
surfaced: 1,248 t
submerged: 1,440 t

Dimensions
Length: 55.9 m (183.4 ft)
Beam: 6.3 m (20.5 ft)
Draught: 5.5 m (17.9 ft)

Speed:
surfaced: 10 kts
snorting: 11 kts
submerged: 22 kts

Range:
surfaced: 6,000 n miles at 8 kts
submerged: 230 at 8 kts; 400 at 4 kts
Diving depth: 250 m (820 ft)

Complement: 34

SUBMARINES

SALTA (S 31)

Builders	components — Howaldtswerke, Kiel, Germany assembly and trials — Rio Santiago Navy Yard, Argentina
Laid down	30 Apr 1970
Launched	9 Nov 1972
Commissioned	7 Mar 1974

SAN LUIS (S 32)

Builders	components — Howaldtswerke, Kiel, Germany assembly and trials — Rio Santiago Navy Yard, Argentina
Laid down	1 Oct 1970
Launched	3 Apr 1973
Commissioned	24 May 1974

Argentine submarine Salta, *one of two Type 209/1200 which have been in service for 22 years*
(Argentine Navy)

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) bow tubes.
Total weapons carried, 14.

TORPEDOES

STN Atlas SST 4 Mod 1

SST 4 (Special Service Target #4) is a wire-guided, heavyweight, 533 mm (21 in) torpedo for use against surface ships and is essentially an export version of the German Navy's DM2 Seal. The 260 kg warhead is in the centre of the weapon with an impact fuse and behind it are the silver-zinc batteries, which are identical to those of the DM2 Seal. The torpedo operates at depths between 4.5 and 460 m with the weapon guided from the launcher submarine until the wire is fully dispensed when the torpedo conducts a passive search; it then uses active homing for the terminal phase or to re-acquire the target.

The design has been improved over the years, especially in the homing head functions and in the stabilisation and related control system and the Argentine Navy is one of those to have acquired the SST Mod 1 upgrading kit, which includes further improvements covering additional return signals (actual course, speed and depth) and a magnetic proximity fuse.

Specifications
Length: 6.08 m (6.55 m with guidance wire dispenser (19.94 ft) (21.49 ft))
Diameter: 533 mm (21 in)
Weight: 1,363 kg (2,998 lb)
Warhead: 260 kg (572 lb)

Propulsion: Electric
Speed: 23-35 kts
Range: 6.6 n miles (12 km) at 35 kts; 15.3 n miles (28 km) at 23 kts
Operating depth: 4.5-460 m

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

Alliant Mk 37
The Mk 37 is a 483 mm (19 in) weapon which is launched from 533 mm (21 in) torpedo tubes, swimming out using guides. Submarine-launched versions are the Mod 0 and Mod 3, (an updated Mod 0), which are both free-running torpedoes which are launched on a target interception course which is maintained until, at a preset range, it initiates a process which arms the warhead and switches in the attack logic circuits. Acquisition takes place at a distance of some 215 m.

Specifications
Length: 3.52 m (11.54 ft)
Diameter: 483 mm (19 in)
Weight: 645 kg (Mod 0/3 warshots)
Warhead: 150 kg HBX-3 (HE)
Speed: 24 kts (Mod 3)
Range: 11.5 n miles (21.5 km)
Max operating depth: 270 m (Mod 3)

Manufacturer/Contractor
Alliant Techsystems, Marine Systems, Hopkins, Minnesota, USA.

MINES

These Argentine submarines are capable of carrying ground mines in their torpedo tubes in place of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES (ESM)

Thomson-CSF DR 2000U
DR 2000U is an F-band ESM and radar warning receiver, designed specifically for submarine applications. The system offers threat warning, surveillance, emitter identification, ELINT, and automatic EW system control capabilities and can also, if required, be interfaced with decoy dispensers or jammers to control their operation. The DR 2000U antenna array consists of an omnidirectional unit for frequency measurements and two concentric sets of six antennas.

Manufacturer/Contractor
Thomson-CSF, Radars and Countermeasures Division, Elancourt, France.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Signaal M8/24
The M8 digital computer-based, fire-control system is standard fitting in all HDW submarines. The system accepts target data inputs from a range of sensors including radar, sonar, passive sound detection systems, periscope observation, consort reports and ship's own navigational data. The display has range scale settings for 20, 10 and 5 km, presenting the positions of all contacts from all sensors simultaneously. One or more sensors may be connected to the computer for torpedo engagement, and up to three targets may be attacked simultaneously. The computer is programmed to provide firing data for wire-guided, programmed, conventional, and other types of torpedo, and performs automatic calculation of target position, course and speed. The CRT display can give true motion, relative motion or off-centred presentation of the tactical situation.

Manufacturer/Contractor
Hollandse Signaalapparaten BV, Hengelo, Netherlands.

RADAR

Thomson-CSF Calypso II
Calypso II is an I-band radar used for surface and air surveillance and target designation, and also for navigation. The antenna is mounted atop a rotating motor unit, at the head of a non-penetrating periscopic mast. Detection range for a 10 m^2 airborne target is 16 n miles.

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

SONARS

STN Atlas CSU 3-4
CSU 3-4 is a fast-scanning medium-range, medium-frequency, active/passive sonar, which can be used as a long-range passive device, an intercept sonar and as an underwater telephone. The equipment has an AN 5039 cylindrical array and uses electronic scanning thus generating less self-noise than the CSU 3-2, which uses an active antenna that is tilted and rotated mechanically.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen, Germany.

Thomson Sintra DUUX-2
DUUX-2 is a passive ranging system , with three transducers each side of the submarine, operating at 5, 7, 12, and 18 kHz. The system covers a 90° arc on each side, with a range accuracy of: 1-5 km — 1 per cent; 5-10 km — 2.5 per cent; 10-20 km — 5 per cent; and 20-30 km — 10 per cent.

Manufacturer/Contractor
Thomson Sintra, Radars and Countermeasures Division, Elancourt, France.

Thomson Sintra DUUG 1D
DUUG 1D is a passive, broadband sonar intercept receiver, with hydrophones located on the forward and after ends of the sail. There is a loudspeaker in the control room to give audio warning of sonar transmissions and approximate target bearing is displayed on a cathode-ray tube (CRT). There is no frequency analysis facility.

Manufacturer/Contractor
Thomson Sintra, Radars and Countermeasures Division, Elancourt, France.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 4 MTU 12V 493 AZ80 diesels; 1.76 MW (2,400 hp(m)) sustained (being replaced — see 'Modernisation')
Alternators: 4 alternators; 1.7 MW
Electric motor: 1 Siemens; 3.36 MW (4,600 hp(m))
Shaft: 1
Battery: 4 batteries, each of 120 cells; 11,500 Ah

FURTHER INFORMATION

San Luis *carried out a lone campaign against the British Task Force in 1982, demonstrating the effect which even one submarine can have on surface operations* (Argentine Navy)

PROGRAMME

The Argentine Navy order for two submarines, placed in 1968, was the second order for the Type 209. This, the original Type 209, was the 'IK 68' design produced by the submarine design bureau, Ingenieurkontor, Lubeck (IKL) and the two boats were built in sections by Howaldtswerke Deutsche Werft (HDW) at Kiel, Germany. They were then shipped to Argentina for assembly at Tandanor, Buenos Aires.

MODERNISATION

Salta has completed a mid-life modernisation at the Domecq Garcia Shipyard, Buenos Aires and has been fitted with new engines, weapons and electrical systems and was relaunched on 4 October 1994. Similar work, which involves separating the hull, started on *San Luis* in late 1991.

OPERATIONAL

The two boats had been in service for eight years when the Falklands (Malvinas) war broke out in 1982 and both immediately went to sea to counter the British task force. *Salta* was forced to returned to port due to a mechanical problem, which kept it in harbour for the rest of the conflict. *San Luis,* however, carried out two attacks, the first on 5 May 1982, when it fired torpedoes at British targets; there were no hits, but British ASW forces then pinned it down for some 20 hours before it made good its escape. The reason for the failure of *San Luis'* torpedoes to hit any targets has never been established, at least in public.

Undeterred, *San Luis* carried out a second attack on 10 May, although this, too, was unsuccessful. Despite the lack of actual hits, *San Luis'* lone campaign was a great success and caused the British task force a problem, although, in the final analysis, it did not actually prevent the British from landing.

THE FUTURE

There have been reports from time to time that these two submarines will be sold. The current refits, however, indicate a long-term desire to retain them, although the other two submarines are currently being offered for sale (see 'Santa Cruz' class).

TUPI

GENERAL SPECIFICATIONS

Country: Brazil

Class: TUPI
Type: 209/1400

In service: 2
Building: 2

Displacement:
surfaced: 1,260 t
submerged: 1,440 t

Dimensions
Length: 61.0 m (200.1 ft)
Beam: 6.2 m (20.3 ft)
Draught: 5.5 (18 ft)

Speed:
surfaced/snorting: 11 kts
dived: 21.5 kts
Range:
surfaced: 8,200 n miles at 8 kts
submerged: 400 n miles at 4 kts
Diving depth: 250 m (820 ft)

Complement: 30

SUBMARINES

TUPI (S 30)

Builder	Howaldtswerke-Deutsche Werft, Kiel, Germany
Laid down	8 Mar 1985
Launched	28 Apr 1987
Commissioned	20 Dec 1988

TAMOIO (S 31)

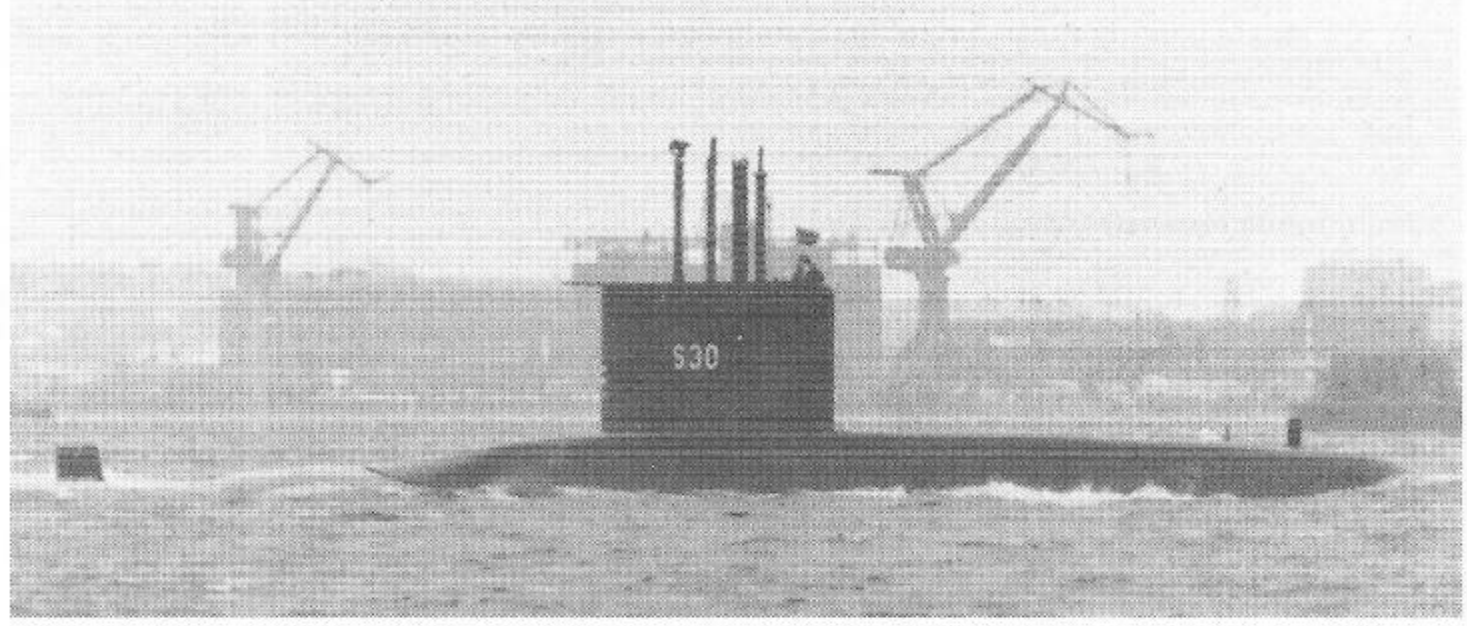
Builder	Arsenal de Marinha, Rio de Janeiro, Brazil
Laid down	15 Jul 1986
Launched	18 Nov 1993
Commissioned	12 Dec 1994

TIMBIRA (S 32)

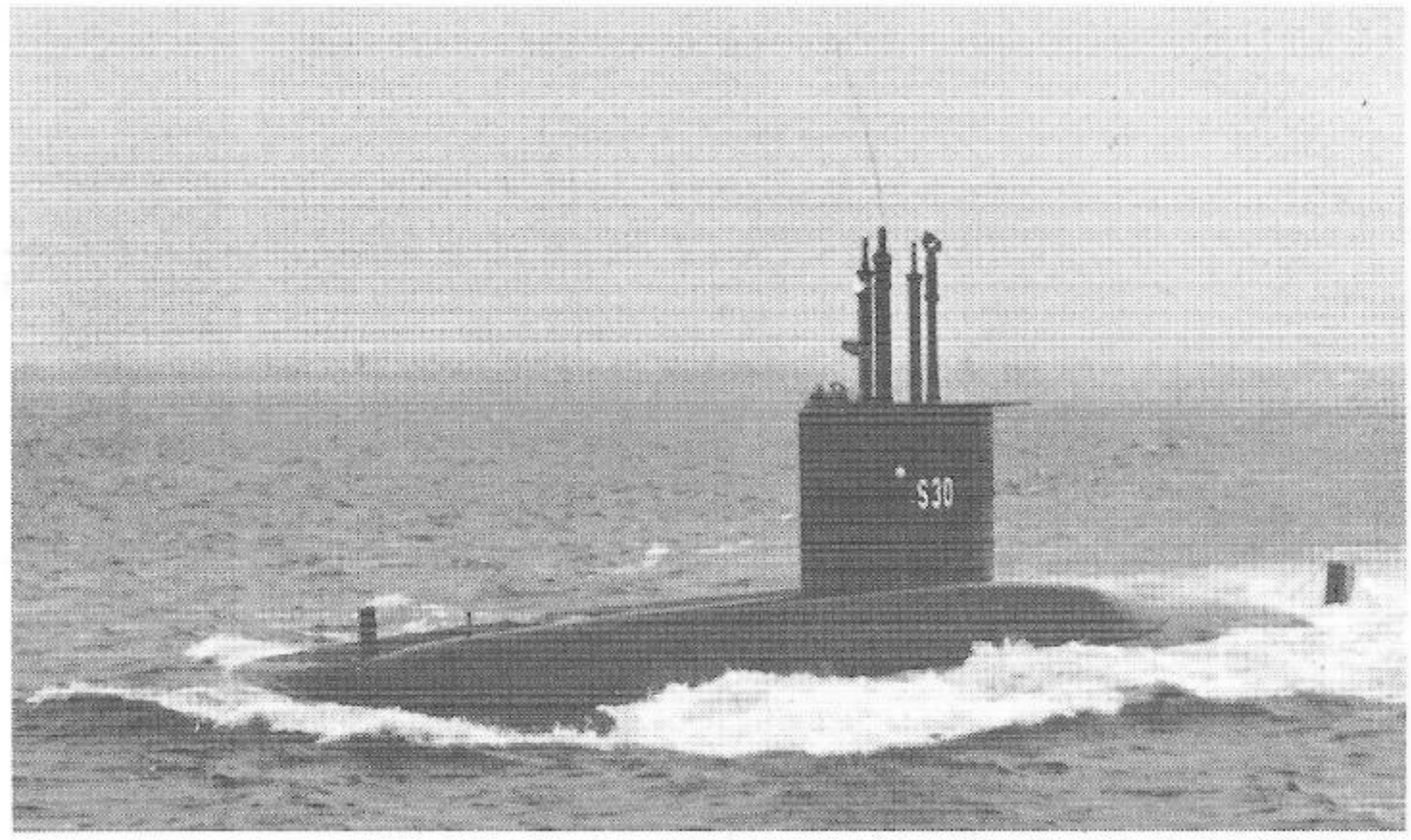
Builder	Arsenal de Marinha, Rio de Janeiro, Brazil
Laid down	15 Sep 1987
Launched	5 Jan 1996
Commissioned	Oct 1996

TAPAJOS (S 33)

Builder	Arsenal de Marinha, Rio de Janeiro, Brazil
Laid down	Mar 1996
Launched	Dec 1997
Commissioned	1999



Tupi *(S 30) running trials in Kiel in 1989* (H & L van Ginderen Collection)



Tupi (Brazilian Navy)

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) bow tubes; swim-out discharge.
Total weapons carried, 16.

TORPEDOES

GEC-Marconi Tigerfish Mk 24 Mod 2

The British Tigerfish torpedo uses the passive mode whenever possible, with the interrogation rate being progressively increased as the torpedo nears the target to improve system accuracy. The onboard computer performs several functions during the attack, including interrogation control, sonar data computation, torpedo steering control and data transmission to the submarine to update its computer memory. The onboard computer is connected through the guidance wire to the submarine's torpedo fire-control computer. During the wire-guidance phase the torpedo's computer responds to the demands of the submarine computer, with wire being dispensed from both torpedo and submarine to avoid any stress due to their relative motion. Wire guidance ceases at the point where the torpedo's automatic three-dimensional passive/active acoustic homing system can control the final run to the target and during this phase the torpedo computer interprets data from the homing system sensors to calculate and then command the appropriate course, subject to a priority overriding steer-off azimuth control from the submarine.

Specifications
Length: 6.46 m (21.19 ft)
Diameter: 533 mm (21 in)
Weight: 1,550 kg (3,417 lb) (in air)
Propulsion: Electrically driven contrarotating propellers
Speed: 24 kts (passive), 35 kts (active)
Range: 7.5-22 n miles (13-39 km) (estimated)
Max operating depth: 610 m (2,000 ft) (estimated)
Warhead: Royal Ordnance 134 kg (295 lb) PBXN 105 warhead
Fuse: Dual-action impact (inertia-type) and proximity (magnetic)
Power: 2 British Chloride silver-zinc oxide batteries driving a 2-speed electric motor
Propellers: 2, contrarotating propellers

Manufacturer/Contractor
GEC-Marconi Underwater Weapons Systems Ltd, Waterlooville, Hampshire, UK.

IPqM anti-submarine torpedo

This torpedo has been developed by the naval research organisation of the Ministry of Marine, the Instituto de Pesquisas da Marinha (IPqM). Some may be carried in combination with the Tigerfish. Details are sparse.

Specifications
Range: 18 km (9.7 n miles) at 45 kts.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thomson-CSF DR 4000U

DR 4000U is an ESM and radar warning receiver covering the C- to J-bands, designed specifically for submarine applications. The system offers threat warning, surveillance, emitter identification, ELINT, and automatic EW system control capabilities and can also, if required, be interfaced with decoy dispensers or jammers to control their operation. The DR 4000U antenna array consists of an omnidirectional unit for frequency measurements and two concentric sets of six antennas, one set for the H to J high band for DF and one set for the C to G low band. The DR 4000U provides a very high intercept probability on even short single pulses, and is very sensitive, using crystal video and IFM techniques on both the omnidirectional and DF channels.

Specifications

Frequency coverage: C-/J-band
Bearing accuracy: Approx ±5°

Manufacturer/Contractor

Thomson-CSF, Radars and Countermeasures Division, Elancourt, France.

Thomson-CSF TRS 3100 (Calyspo III)

Calypso III is an export version of the French Navy's DRUA-33 I/J-band radar and was developed in conjunction with IKL for use aboard Type 209 submarines. It is used for surface and air surveillance and target designation, and also for navigation. The antenna is mounted atop a rotating motor unit, at the head of a non-penetrating periscopic mast. Detection range for a typical ASW aircraft at 2,500 m altitude is 18 n miles, and for a surface vessel depends on the radar horizon.

Specifications

Band: I band
Beam: 3 × 8.5°
Peak power: 70 kW
Gain: <29 dB
Pulsewidth: 0.15/0.5 µs
Pulse repetition frequency: 1,500-3,000 or 500-1,000 pps
Scan rate: 12/24 rpm

Manufacturer/Contractor

Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Ferranti KAFS action data automation system

KAFS (SSK Action information and Fire-control System) is designed for use by conventional submarines of all sizes, using up-to-date processing techniques and software algorithms to provide a wide range of operational facilities including sensor data handling, target-motion analysis, picture compilation, fire control, tactical calculations and data recording. The control room console is linked by a MIL-STD-1553B databus to the weapon control equipment in the torpedo room. Full combat information and fire control facilities are provided at each console operator position and either operator can control the whole system thereby allowing one position to be shut down in patrol state. Each console position has two CRT displays, two command data panels, and a weapon control and system status panel. The Brazilian Navy has taken delivery of five systems, four are installed in submarines and one is in a shore training facility. Three were built under subcontract by SFB Informatica in Rio de Janeiro. KAFS can control up to four torpedoes against separate targets and can also launch unguided torpedoes or mines.

Manufacturer/Contractor

Ferranti Naval Systems, Portsmouth, UK.

SONAR

STN Atlas CSU-83/1

The CSU-83 (DBQS-21) sonar suite is designed for submarines of 400 tonnes displacement and upwards, and is the primary sensor of the submarine fire-control and command system of the German Navy. It comprises a passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array covering the frequencies 10 Hz to 2 kHz, a towed array, and two self-noise detectors. The system is claimed to provide high probability of detection over 360°.

Manufacturer/Contractor

STN Atlas Elektronik, Bremen, Germany.

PERISCOPES

Kollmorgen Model 76

Two Kollmorgen Model 76 periscopes, one for search, the other for attack.

Specifications

Magnification/Field of View: 1.5×; FOV 32°; 6×; FOV 8°
Elevation:
search version: +60 to −10°
attack version: +74 to −10°

Manufacturer/Contractor

Kollmorgen Electro Optical, Northampton, Massachussets, USA.

PROPULSION

Specification

System: Diesel-electric
Main Machinery: 4 MTU 12V 493 AZ80 GA31L: 1.76 MW (2,400 hp(m))
Alternators: 4—1.7 MW
Electric motor: 1 Siemens; 3.36 MW (4,600 hp(m)) sustained
Shafts: 1
Battery: 4 batteries, each of 120 cells

FURTHER INFORMATION

PROGRAMME

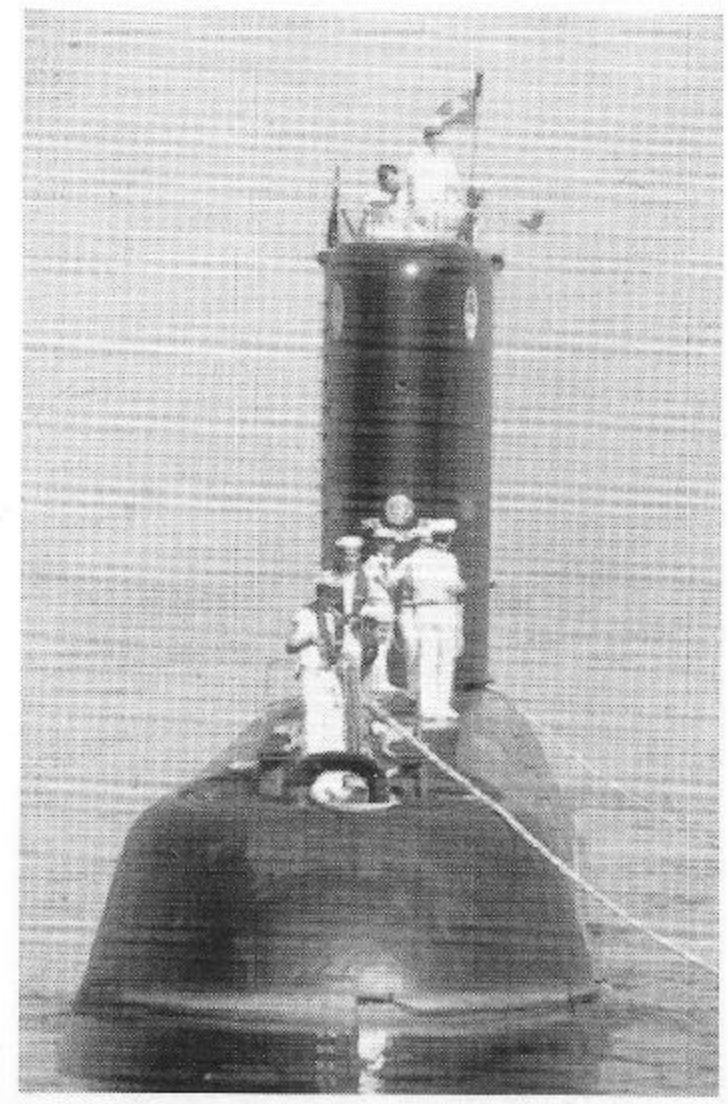
The order for these submarines represented the first purchase of German naval equipment by the Brazilian Navy, which had previously looked to the United States and the United Kingdom for its ships. The contract was signed with Howaldtswerke in February 1984 and financial negotiations with the Federal German Government were completed in the following October. The original plan was to purchase six boats, of which one would be built in Germany and the remaining five in Brazil, with the last two being to an 'Improved Tupi' design. The total to be built in Brazil has, however, now been reduced to three.

WEAPON LOAD

According to several sources, the Brazilian Type 209/1400 is able to carry eight reloads for its eight torpedo tubes, whereas all other Type 209s can only accommodate six reloads.

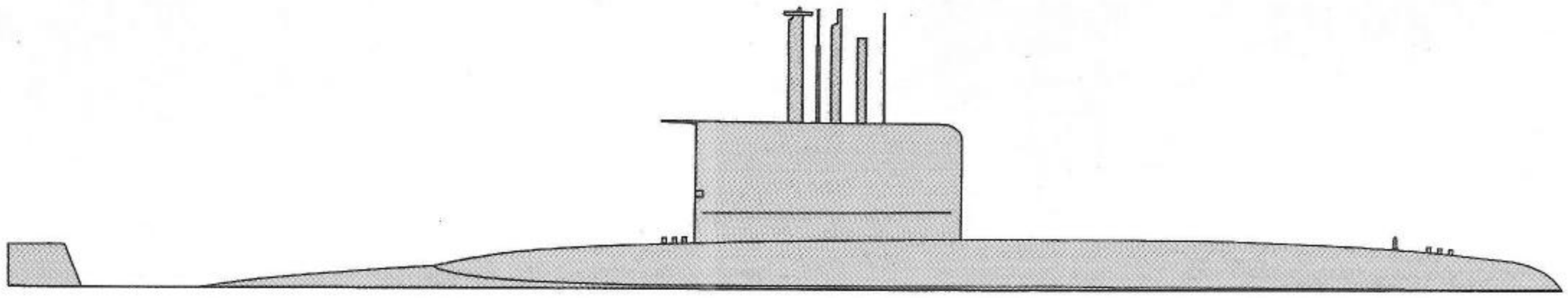
OPERATIONAL

Tamoio was undergoing sea trials at the end of 1994.



'Tupi' class (Brazilian Navy)

THOMSON (209/1300)



Thomson (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Chile

Class: THOMSON
Type: 209/1300

Built: 2
In service: 2

Displacement:
surfaced: 1,260 t
submerged: 1,390 t

Dimensions
Length: 59.5 m (195.2 ft)
Beam: 6.2 m (20.3 ft)
Draught: 5.5 m (18 ft)

Speed:
surfaced: 11 kts
submerged: 21.5 kts
Range:
snorkel: 8,200 n miles at 8 kts
submerged: 400 n miles at 4 kts/16 n miles at 21.5 kts

Complement: 32 (5 officers)

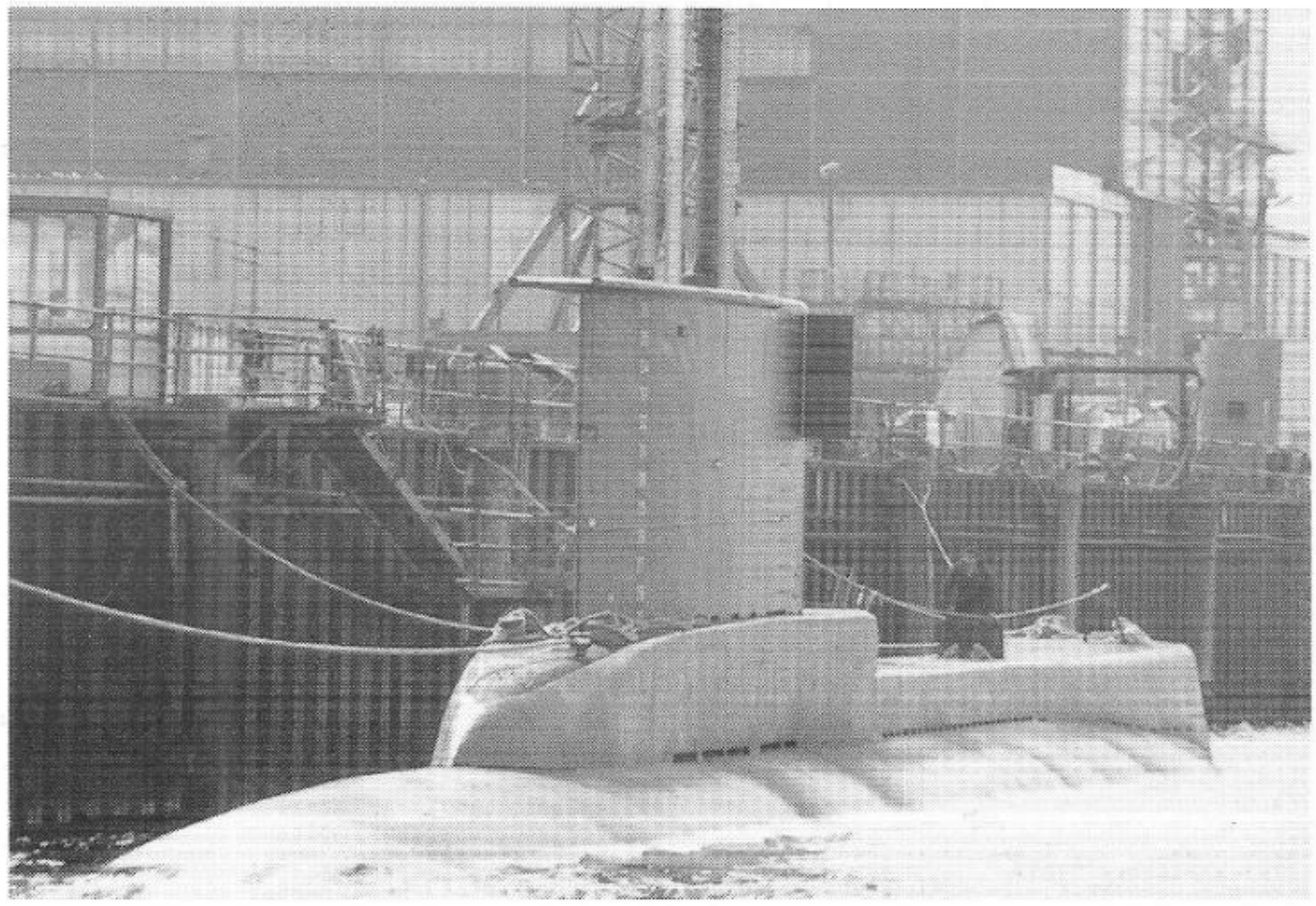
SUBMARINES

THOMSON (20)

Builder	Howaldtswerke, Kiel, Germany
Laid down	1 Nov 1980
Launched	28 Oct 1982
Commissioned	7 May 1984

SIMPSON (21)

Builder	Howaldtswerke, Kiel, Germany
Laid down	15 Feb 1982
Launched	29 Jul 1983
Commissioned	18 Aug 1984



Simpson *(21). The two Chilean boats have sails and masts 0.5 m (1.64 ft) longer than in other Type 209s to cope with the high seas off the coasts of Chile* (H & L van Ginderen Collection)

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) bow tubes.
Total weapon load, 14.

TORPEDOES

STN Atlas SUT

SUT (Surface and Underwater Target) is a dual-purpose, wire-guided torpedo for use against both surface and submarine targets. It is electrically propelled and the wire guidance gives immunity to interference with a two-way datalink between vessel and torpedo. The acoustic homing head has long acquisition ranges and a wide search sector for active and passive operation. The large payload with combined fuze systems ensures the optimum effect of explosive power. The SUT operates at great depths as well as in very shallow waters. Consort operation permits exploitation of the full over-the-horizon range of the SUT.

Specifications
Length: 6.15 m (20.18 ft)
Diameter: 533 mm (21 in)
Weight: 1,420 kg (3,130 lb)
Warhead: 260 kg (573 lb)
Speed: Selectable, max 35 kts
Range: 6.5 n miles (12 km) at 35 kts; 15 n miles (28 km) at 23 kts
Fuze: Magnetic, proximity and impact

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen/Hamburg, Germany.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Racal Porpoise

Chilean submarines are fitted with Racal Porpoise, a fully automatic ESM system which receives signals, measures their parameters, compares these with those contained in a radar threat library. The system is integrated with the vessel's fire-control and communications systems and with periscope-mounted radar warning equipments. Porpoise gives an alert warning when prime threats, such as helicopter or maritime surveillance radars, reach a preprogrammed danger level. The Porpoise antenna is a compact six port system giving good bearing accuracy and may be mounted on either hull penetrating or non-hull penetrating masts. It is built of titanium to reduce weight and overcome corrosion, and is pressure resistant to 60 bar.

Specifications
Frequency range: 2-18 GHz
Azimuth coverage: 360°
DF accuracy: 5° RMS
Dynamic range: 60 dB
Library: Up to 2,000 emitter modes

Manufacturer/Contractor
Racal Radar Defence Systems Ltd, Chessington, UK.

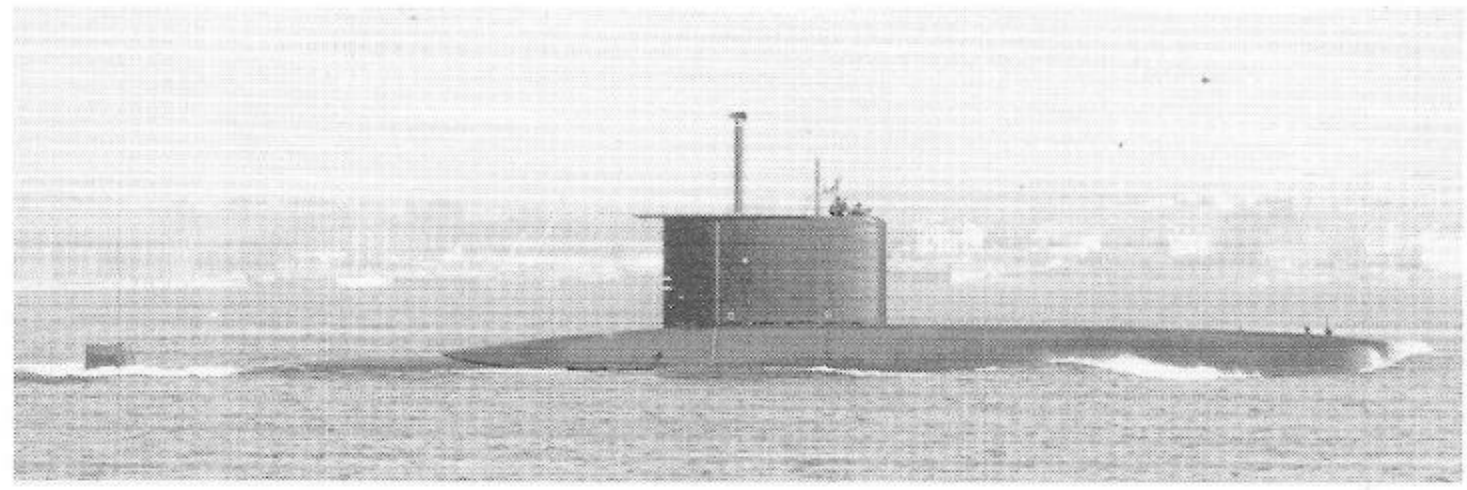
COMMAND AND CONTROL SYSTEMS

RADAR

Thomson-CSF Calypso II

Calypso II is an I-band radar used for surface and air surveillance and target designation, and also for navigation. The antenna is mounted atop a rotating motor unit, at the head of a non-penetrating periscopic mast. Detection range for a 10 m^2 airborne target is 16 n miles.

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.



Simpson *(21)* (H & L van Ginderen Collection)

SONARS

STN Atlas CSU 3-4

CSU 3-4 is a fast-scanning medium-range, medium-frequency, active/passive sonar, which can be used as a long-range passive device, an intercept sonar and as an underwater telephone. The equipment has a cylindrical transducer array 0.9 m (2.95 ft) high and 3.0 m (9.8 ft) in diameter with electronic beam-steering and is equipped with automatic interference suppression against acoustic countermeasures. CSU 3-4 is intended primarily for shallow water use, and is able to track four targets simultaneously.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen, Germany.

STN Atlas PRS 3-15

PRS 3-15 passive ranging sonar is an optional add-on to the CSU 3-4, and the Chilean Navy is one of the few to have adopted it. It is used for the passive detection and rangefinding on submarine target. The 15-stave array has a high-directivity index giving a good signal-to-noise ratio, and suppression of adjacent targets that are not of interest. Six individual arrays are mounted along the hull, three on the starboard side and three on the port side.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen, Germany.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 4 MTU 12V 493 AZ80 GA31L; 1.76 MW (2,400 hp(m)) sustained
Alternators: 4 Piller; 1.7 MW
Electric motor: 1 Siemens; 3.38 MW (4,600 hp(m)) sustained
Shafts: 1
Battery: 4 batteries, each of 120 cells

FURTHER INFORMATION

PROGRAMME

These two submarines were ordered from Howaldtswerke, Kiel in 1980 and delivered in 1984.

DESIGN

These submarines are of standard IKL design except that they both have the sail and associated masts lengthened by 50 cm to cope with the high waves encountered off the Chilean coast.

MODERNISATION

Many other users of Type 209s return their submarines to Germany for refitting by HKW, but the Chilean Navy has made use of its own advanced navy yard, operated by Asmar at Talcahuano. Both boats have undergone 10 month refits, *Thomson* completing in late 1990 and *Simpson* in 1991, and ASMAR is now seeking to carry out similar refits for Type 209s in other South American navies.

THE FUTURE

Two more Type 209s were projected in the 1988 Five-Year Plan but this has been overtaken by the requirement for a new class of four of similar displacement. Further German-designed boats may well be under consideration, but it is also known the four redundant British 'Upholder' class submarines were offered to the Chilean Navy in 1996, presumably at a 'competitive' price.

PIJAO

GENERAL SPECIFICATIONS

Country: Colombia

Class: PIJAO
Type: 209/1200

Built: 2
In service: 2

Displacement:
surfaced: 1,180 t
submerged: 1,285 t

Dimensions
Length: 55.9 m (183.4 ft)
Beam: 6.3 m (20.5 ft)
Draught: 5.4 m (17.9 ft)

Speed:
surfaced: 11 kts
submerged: 22 kts
Diving depth: 250 m (820 ft)
Range:
surfaced: 8,000 n miles at 8 kts
submerged: 4,000 n miles at 4 kts

Complement: 34 (7 officers)

SUBMARINES

PIJAO (SS 28)

Builder	Howaldtswerke, Kiel, Germany
Laid down	1 Apr 1972
Launched	10 Apr 1974
Commissioned	18 Apr 1975

TAYRONA (SS 29)

Builder	Howaldtswerke, Kiel, Germany
Laid down	1 May 1972
Launched	16 Jul 1974
Commissioned	16 Jul 1975

Tayrona *(SS 29). The two boats of the 'Pijao' class are the first submarines to be operated by the Colombian Navy* (H & L van Ginderen Collection)

WEAPONS SYSTEMS

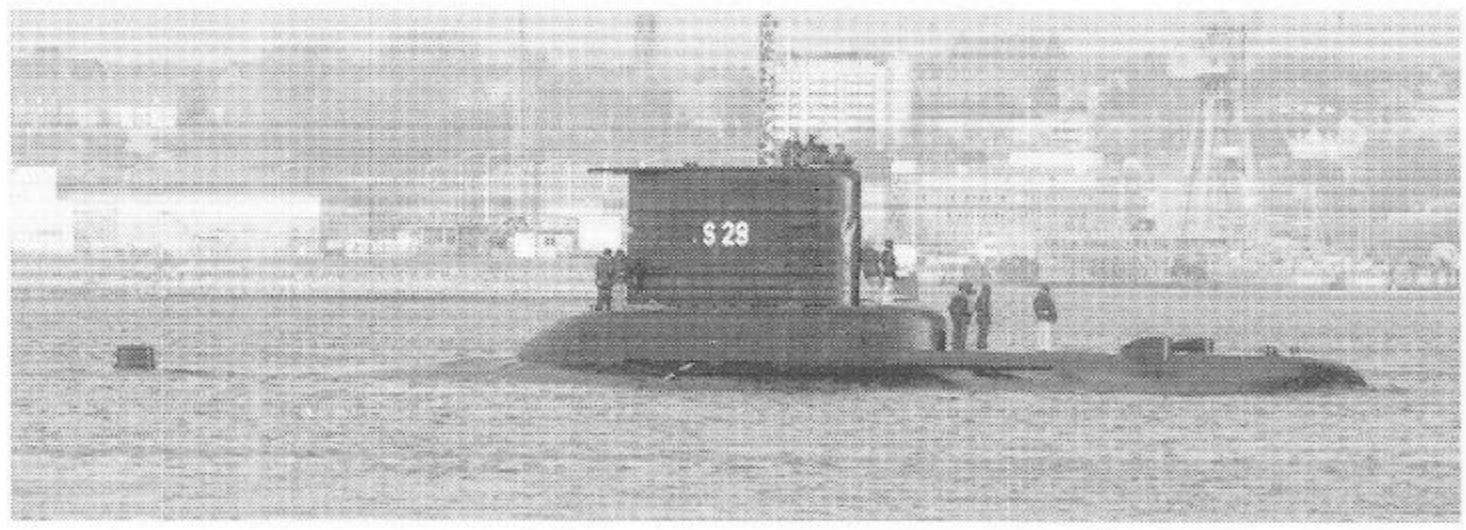
TUBES

Eight 533 mm (21 in) bow tubes, swim-out discharge. Total weapon load, 14.

TORPEDOES

STN Atlas SUT

SUT (Surface and Underwater Target) is a dual-purpose, wire-guided torpedo for use against both surface and submarine targets. It is electrically propelled and the wire guidance gives immunity to interference with a two-way datalink between vessel and torpedo. The acoustic homing head has long acquisition ranges and a wide search sector for active and passive operation. The large payload with combined fuze systems ensures the optimum effect of explosive power. The SUT operates at great depths as well as in very shallow waters. Consort operation permits exploitation of the full over-the-horizon range of the SUT.



Tayrona *(SS 29) at Kiel, Germany on completion of the 1991 refit* (H & L van Ginderen Collection)

Specifications
Length: 6.15 m (20.18 ft)
Diameter: 533 mm (21 in)
Weight: 1,420 kg (3,130 lb)
Warhead: 260 kg (573 lb)
Speed: Selectable, max 35 kts
Range: 6.5 n miles (12 km) at 35 kts; 15 n miles (28 km) at 23 kts
Fuze: Magnetic, proximity and impact

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Signaal M8/24

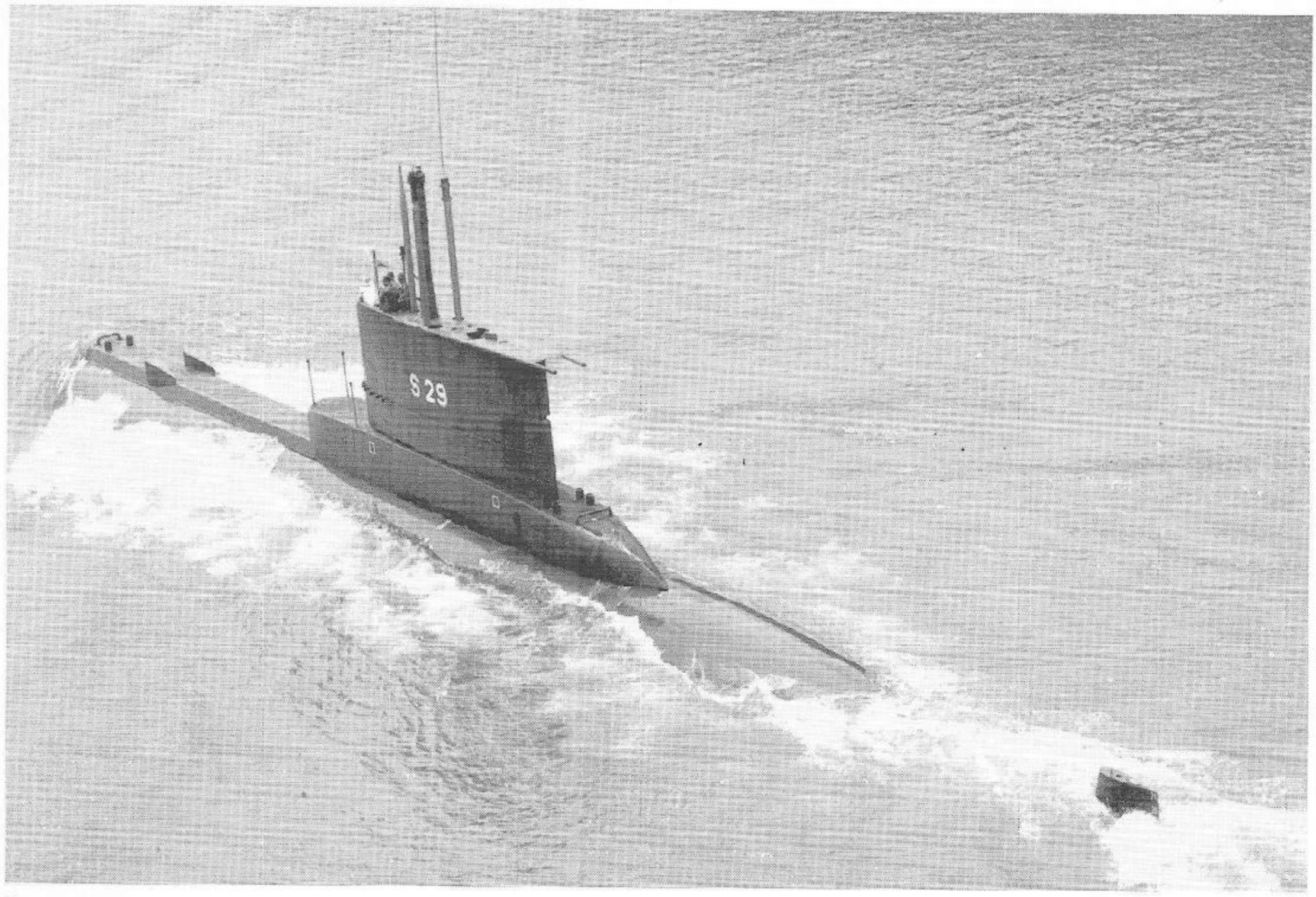
The M8 digital computer-based, fire-control system is standard fitting in all HDW submarines. The system accepts target data inputs from a range of sensors including radar, active sonar, passive sound detection systems, periscope observation, consort reports and ship's own navigational data. The display has range scale settings for 20, 10 and 5 km, presenting the positions of all contacts from all sensors simultaneously. One or more sensors may be connected to the computer for torpedo engagement, and up to three targets may be attacked simultaneously. The computer is programmed to provide firing data for wire-guided, programmed, conventional, and other types of torpedo, and performs automatic calculation of target position, course and speed. The CRT display can give true motion, relative motion or off-centred presentation of the tactical situation.

Manufacturer/Contractor
Hollandse Signaalapparaten BV, Hengelo, Netherlands.

RADARS

Thomson-CSF Calypso II

Calypso II is an I-band radar used for surface and air



Tayrona *(SS 29)* (H & L van Ginderen Collection)

surveillance and target designation, and also for navigation. The antenna is mounted atop a rotating motor unit, at the head of a non-penetrating periscopic mast. Detection range for a 10 m² airborne target is 16 n miles.

Manufacturer/Contractor

Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

SONAR

STN Atlas CSU 3-2

CSU 3-2 is a fast-scanning medium-range, medium-frequency, active/passive sonar, which can be used as a long-range passive device, an intercept sonar and as an underwater telephone. The equipment has a chin array, with 96 staves arranged in a horseshoe. In these Colombian boats the sonar suite includes a PRS 3-4 passive ranging sonar.

Manufacturer/Contractor

STN Atlas Elektronik GmbH, Bremen, Germany.

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 4 MTU 12V 493 AZ80; 1.76 MW (2,400 hp(m)) sustained
Alternators: 4 AEG; 1.7 MW
Electric motor: 1 Siemens motor; 3.38 MW (4,600 hp (m)) sustained
Shafts: 1
Battery: 4—120-cell batteries

FURTHER INFORMATION

PROGRAMME

These two submarines, the first to be operated by the Colombian Navy, are virtually identical to the Greek 'Glavkos' class. They were ordered in 1971 and delivered in 1975.

Two more are required and an interest has been expressed in the Type 1700s being offered for sale by Argentina, but money is not available. Both were refitted by HDW at Kiel in 1990-91, which included a complete replacement of the main batteries.

OPERATIONAL

Both are active.

SHYRI

GENERAL SPECIFICATIONS

Country: Ecuador

Class: SHYRI
Type: 209/1300

In service: 2

Displacement
surfaced: 1,285 t
submerged: 1,390 t

Dimensions
Length: 59.5 m (195.1 ft)
Beam: 6.3 m (20.5 ft)
Draught: 5.4 m (17.9 ft)

Speed:
surfaced/snorting: 11 kts
submerged: 21.5 kts

Complement: 33 (5 officers)

SUBMARINES

SHYRI (S 101 (ex-S 11))
Builder Howaldtswerke, Kiel, Germany
Laid down 5 Aug 1974
Launched 6 Oct 1976
Commissioned 5 Nov 1977

HUANCAVILCA (S 102 (ex-S 12))
Builder Howaldtswerke, Kiel, Germany
Laid down 2 Jan 1975
Launched 15 Mar 1977
Commissioned 16 Mar 1978

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) bow tubes.
Total weapon load, 14.

TORPEDOES

STN Atlas SUT

SUT (Surface and Underwater Target) is a dual-purpose, wire-guided torpedo for use against both surface and submarine targets. It is electrically propelled and the wire guidance gives immunity to interference with a two-way datalink between vessel and torpedo. The acoustic homing head has long acquisition ranges and a wide search sector for active and passive operation. The large payload with combined fuze systems ensures the optimum effect of explosive power. The SUT operates at great depths as well as in very shallow waters. Consort operation permits exploitation of the full over-the-horizon range of the SUT.

Specifications
Length: 6.15 m (20.18 ft)
Diameter: 533 mm (21 in)
Weight: 1,420 kg (3,130 lb)
Warhead: 260 kg (573.2 lb)
Speed: Selectable, max 35 kts
Range: 6.5 n miles (12 km) at 35 kts; 15 n miles (28 km) at 23 kts
Fuze: Magnetic, proximity and impact

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen/Hamburg, Germany.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thomson-CSF DR 2000U

DR 2000U is an F-band ESM and radar warning receiver, designed specifically for submarine applications. The system offers threat warning, surveillance, emitter identification, ELINT, and automatic EW system control capabilities and can also, if required, be interfaced with decoy dispensers or jammers to control their operation. The DR 2000U antenna array consists of an omnidirectional unit for frequency measurements and two concentric sets of six antennas.

Manufacturer/Contractor
Thomson-CSF, Radars and Countermeasures Division, Elancourt, France.

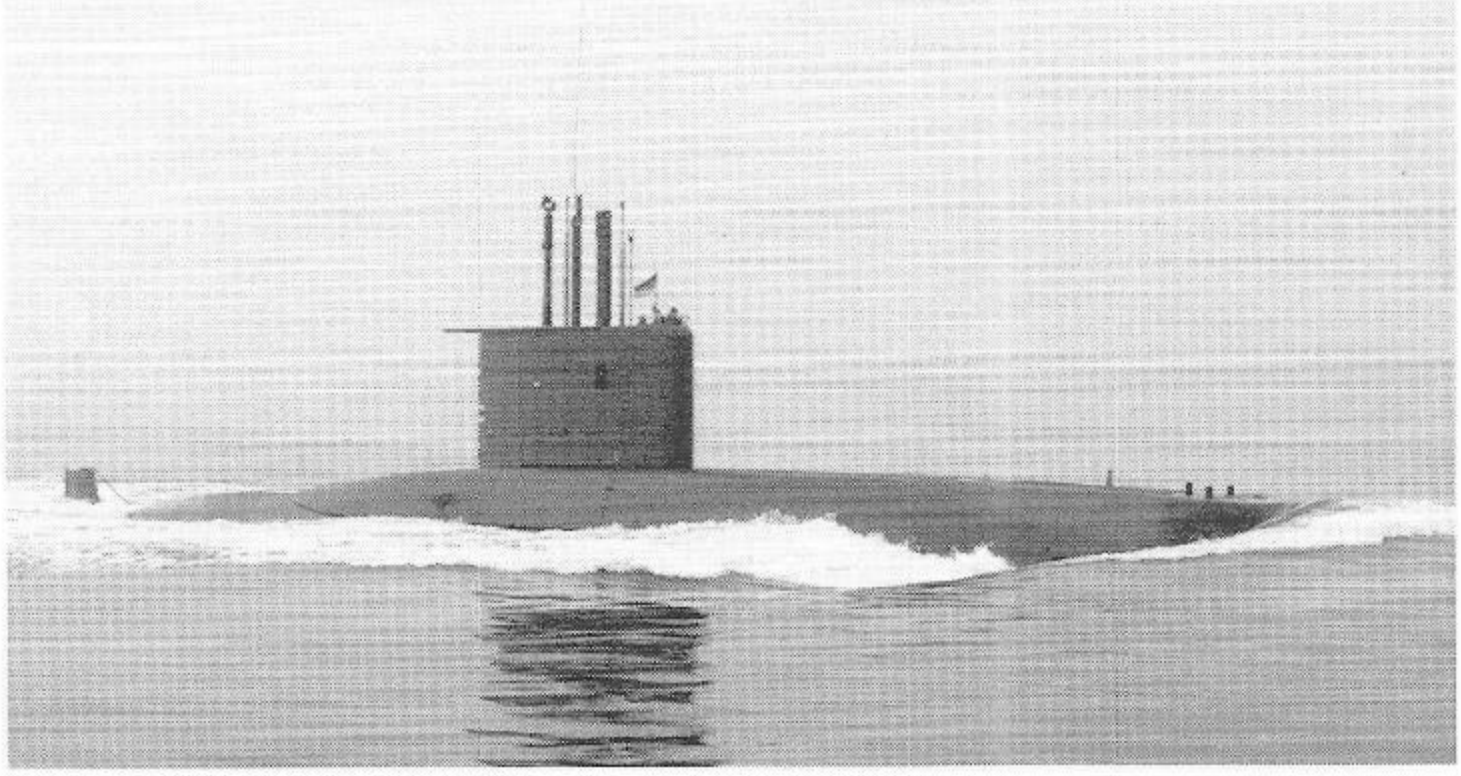
COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Signaal M8/24

The M8 digital computer-based, fire-control system is standard fitting in all HDW submarines. The system accepts target data inputs from a range of sensors including radar, active sonar, passive sound detection systems, periscope observation, consort reports and ship's own navigational data. The display has range scale settings for 20, 10 and 5 km, presenting the positions of all contacts from all sensors simultaneously. One or more sensors may be connected to the computer for torpedo engagement, and up to three targets may be attacked simultaneously. The computer is programmed to provide firing data for wire-guided, programmed, conventional, and other types of torpedo, and performs automatic calculation of target position, course and speed. The CRT display can give true motion, relative motion or off-centred presentation of the tactical situation.

Manufacturer/Contractor
Hollandse Signaalapparaten BV, Hengelo, Netherlands.



A Type 209/1300 similar to the two operated by the navy of Ecuador (HDW)

RADARS

Thomson-CSF Calypso II

Calypso II is an I-band radar used for surface and air surveillance and target designation, and also for navigation. The antenna is mounted atop a rotating motor unit, at the head of a non-penetrating periscopic mast. Detection range for a 10 m^2 airborne target is 16 n miles.

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

STN Atlas CSU 3-2

CSU 3-2 is a fast-scanning medium-range, medium-frequency, active/passive sonar, which can be used as

a long-range passive device, an intercept sonar and as an underwater telephone. The equipment has a chin array, with 96 staves arranged in a horseshoe. The Ecuadorean Type 209s include a DUUX-2 passive ranging suite (see below).

Manufacturer/Contractor

STN Atlas Elektronik GmbH, Bremen, Germany.

SONAR

DUUX-2

DUUX-2 is a passive ranging system , with three transducers each side of the submarine, operating at 5, 7, 12, and 18 kHz. The system covers a 90° arc on each side, with a range accuracy of: 1-5 km — 1 per cent; 5-10 km — 2.5 per cent; 10-20 km — 5 per cent; and 20-30 km — 10 per cent.

Manufacturer/Contractor

Thomson Sintra, Radars and Countermeasures Division, Elancourt, France.

PROPULSION

Specifications

System: Diesel-electric

Main Machinery: 4 MTU 12V 493 AZ80 GA31L; 1.76 MW (2,400 hp(m)) sustained

Alternators: 4 Siemens; 1.7 MW

Electric motor: 1 Siemens; 3.38 MW (4,600 hp(m)) sustained

Shafts: 1

Battery: 4 batteries, each of 120 cells

FURTHER INFORMATION

PROGRAMME

These were ordered in March 1974 and are virtually identical to the Greek 'Glavkos' class.

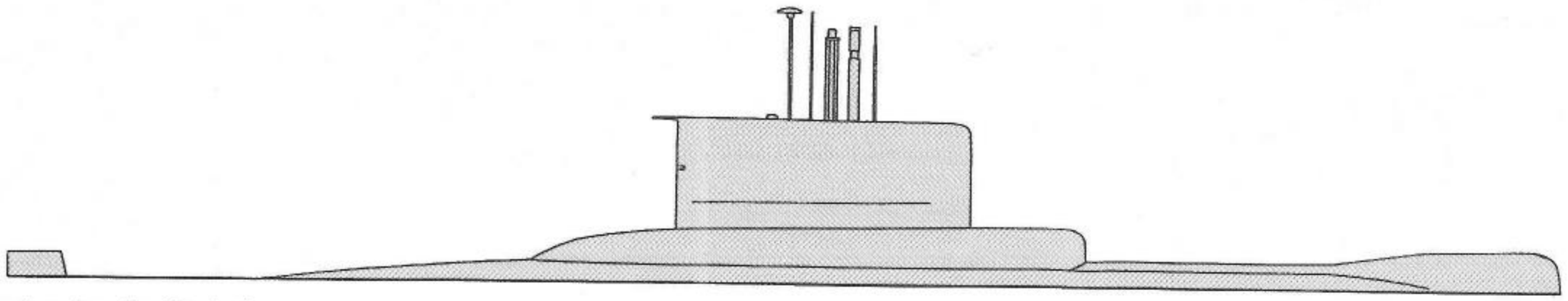
Refits

Shyri underwent a major refit in West Germany in 1983, followed by *Huancavilca* in 1984. Second refits were authorised in 1992 but have yet to be carried out and may be done at the Chilean ASMAR yard at Talcahuano.

OPERATIONAL

Based at Guayaquil.

GLAVKOS



Glavkos class (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Greece

Class: GLAVKOS
Type:
209/1100: S 110, S 111, S 113
209/1200: S 112 and S 116 to S-119

Built: 8
In service: 8

Displacement:
surfaced: 1,100 t
submerged: 1,210 t (S 110, 111, 113); 1,285 t (S 112 and 116-119)

Dimensions
Length: 54.4 m (178.4 ft) (S 110, 111, 113); 55.9 m (183.4 ft) (S 112, 116-119)
Beam: 6.2 m (20.3 ft)
Draught: 5.5 m (17.9 ft)

Speed:
surfaced: 11 kts
submerged: 21.5 kts
Diving depth: 250 m (820 ft).
Endurance: 50 days.

Complement: 31 (6 officers)

SUBMARINES

GLAVKOS (S 110)
Builder Howaldtswerke, Kiel, Germany
Laid down 1 Sep 1968
Launched 15 Sep 1970
Commissioned 6 Sep 1971

NEREUS (S 111)
Builder Howaldtswerke, Kiel, Germany
Laid down 15 Jan 1969
Launched 7 Jun 1971
Commissioned 10 Feb 1972

TRITON (S 112)
Builder Howaldtswerke, Kiel, Germany
Laid down 1 Jun 1969
Launched 14 Oct 1971
Commissioned 8 Aug 1972

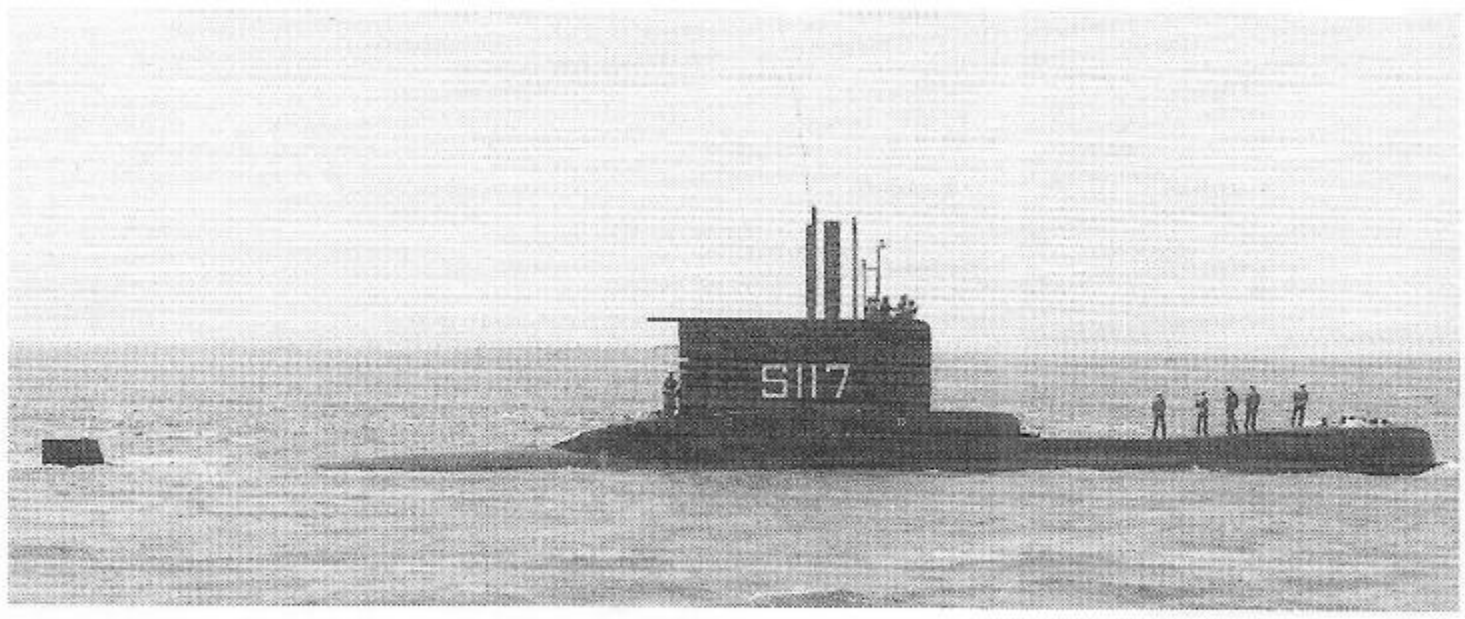
PROTEUS (S 113)
Builder Howaldtswerke, Kiel, Germany
Laid down 1 Oct 1969
Launched 1 Feb 1972
Commissioned 8 Aug 1972

POSYDON (S 116)
Builder Howaldtswerke, Kiel, Germany
Laid down 15 Jan 1976
Launched 21 Mar 1978
Commissioned 22 Mar 1979

AMPHITRITE (S 117)
Builder Howaldtswerke, Kiel, Germany
Laid down 26 Apr 1976
Launched 14 Jun 1978
Commissioned 3 Jul 1979

OKEANOS (S 118)
Builder Howaldtswerke, Kiel, Germany
Laid down 1 Oct 1976
Launched 16 Nov 1978
Commissioned 15 Nov 1979

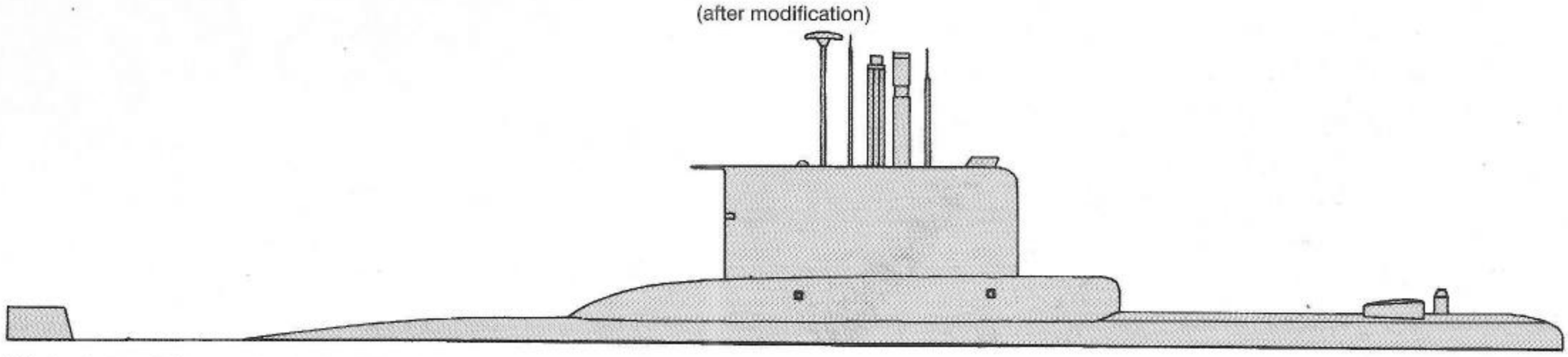
PONTOS (S 119)
Builder Howaldtswerke, Kiel, Germany
Laid down 25 Jan 1977
Launched 21 Mar 1979
Commissioned 29 Apr 1980



Amphitrite *(S 117), one of five Type 209/1200* (H & L van Ginderen Collection)

WEAPONS SYSTEMS

(after modification)



'Glavkos' class (after modernisation) (Ian Sturton)

ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Sub-Harpoon

These boats are being fitted to take Sub-Harpoon during their modernisation refits. These may be either Block 1B or Block 1C versions. Block 1C has a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three pre-selected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for

the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuse: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warheads).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

Eight 533 mm (21 in) bow tubes; note that only four of the tubes are modified to discharge Sub-Harpoon. Total weapon load, 14.

TORPEDOES

STN Atlas SUT

SUT (Surface and Underwater Target) is a dual-purpose, wire-guided torpedo for use against both surface and submarine targets. It is electrically propelled and the wire guidance gives immunity to interference with a two-way datalink between vessel and torpedo. The acoustic homing head has long acquisition ranges and a wide search sector for active and passive operation. The large payload with combined fuze systems ensures the optimum effect of explosive power. The SUT operates at great depths as well as in very shallow waters. Consort operation permits exploitation of the full over-the-horizon range of the SUT.

Specifications

Length: 6.15 m (20.18 ft)
Diameter: 533 mm (21 in)
Weight: 1,420 kg (3,130 lb)
Warhead: 260 kg (573 lb)
Speed: Selectable, max 35 kts
Range: 6.5 n miles (12 km) at 35 kts; 15 n miles (28 km) at 23 kts
Fuze: Magnetic, proximity and impact

Manufacturer/Contractor

STN Atlas Elektronik, Bremen/Hamburg, Germany.

ELECTRONIC WARFARE SYSTEMS

(after modification)

ELECTRONIC SUPPORT MEASURES (ESM)

ARGOSystems AR-700-S5

Argo AR-700-S5 is being installed in the modernised boats to replace the previous Thomson-CSF DR 2000U. The AR-700 provides ESM and DF functions over the frequency range 2 to 18 GHz with a system sensitivity of −60 dBm, monopulse DF accuracy of 5° RMS, frequency measurement accuracy of 4 MHz, one second reaction time and pulse processing of 1.5 Mpps. The embedded signal processor includes a library to identify signals.

Manufacturer/Contractor

ARGOSystems, Sunnyvale, California, USA.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

UNISYS/GETEN Kanaris

The Kanaris fire-control system has been developed by Unisys Government Systems Group in collaboration with the Hellenic Navy's Research and Development Centre (GETEN) for the 'Glavkos' class submarines. The system consists of a two-cabinet firing distribution unit and a main control unit with two consoles. The two consoles are Unisys Tactical Modular Displays (TMDs), both of which have embedded AN/UYK-44 computers, permitting the system to handle four types of weapon (that is, Sub-Harpoon and three different types of torpedo), while up to six torpedoes can be controlled simultaneously. Five systems have been ordered: four for shipborne use and the fifth as a land-based training unit.

Manufacturers/Contractors

Unisys Government Systems Group, Eagan, Minnesota, USA.
GETEN (Hellenic Navy Research and Development Centre), Greece.

RADAR

Thomson-CSF Calypso II

Calypso II is an I-band radar used for surface and air surveillance and target designation, and also for navigation. The antenna is mounted atop a rotating motor unit, at the head of a non-penetrating periscopic mast. Detection range for a 10 m² airborne target is 16 n miles.

Manufacturer/Contractor

Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

Pontos *(S 119) was the last of the Type 209/1200s to be completed for Greece* (H & L van Ginderen Collection)

SONARS

STN Atlas CSU-83

The CSU-83 (DBQS-21) sonar suite has been installed in all boats during the current modernisation process. It is the primary sensor of the submarine fire-control and command system of the German Navy. It comprises a passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array covering the frequencies 10 Hz to 2 kHz, a towed array, and two self-noise detectors. The system is claimed to provide high probability of detection over 360°. The suite also includes the STN Atlas PRS-3-4 passive ranging array.

Manufacturer/Contractor

STN Atlas Elektronik, Bremen, Germany.

Thomson-CSF DUUX-2

DUUX-2 is a passive ranging system, with three transducers each side of the submarine, operating at 5, 7, 12, and 18 kHz. The system covers a 90° arc on each side, with a range accuracy of: 1-5 km — 1 per cent; 5-10 km — 2.5 per cent; 10-20 km — 5 per cent; and 20-30 km — 10 per cent.

Manufacturer/Contractor

Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

NAVIGATION

Sperry Mk 29 Mod 3 inertial navigation system
Magnavox global positioning system (GPS)
Omega
Satellite navigation equipment.

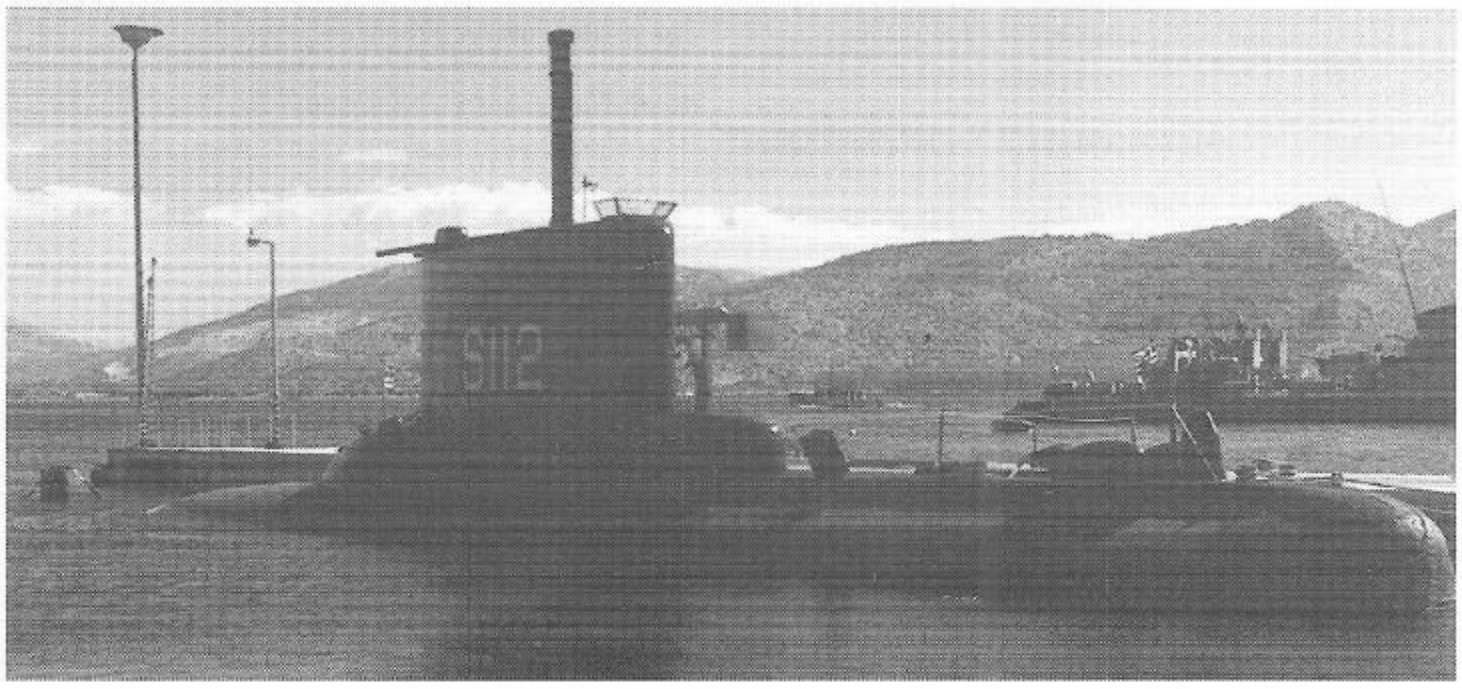
PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 4 MTU 12V 493 AZ80; 1.76 MW (2,400 hp(m)) sustained
Alternators: 4 Siemens; 1.7 MW
Electric motor: 1 Siemens motor; 3.38 MW (4,600 hp (m)) sustained
Shaft: 1
Battery: 4 batteries, each of 120 cells

FURTHER INFORMATION

PROGRAMME

The Hellenic Navy was the first customer for the Type 209, ordering four Type 209/1100s in the mid-1960s. In the event, three were completed as Type 209/1100s, while one boat (S 112) and all four of a second order were completed as Type 209/1200s. They are currently undergoing a major modernisation which will extend their lives well beyond the nominal 30-year point, which they will reach in 2001-2002.



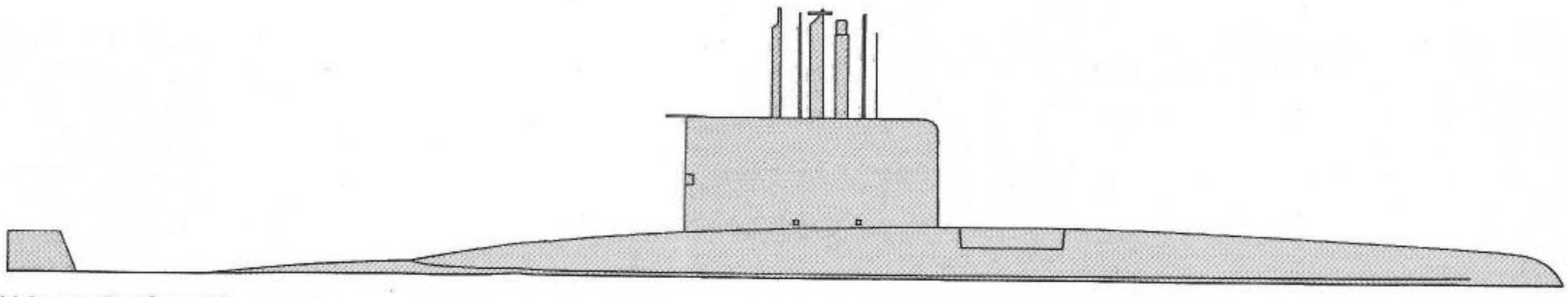
Triton *(S 112) after modernisation; note the new sonar 'horns' on the bow* (Hellenic Navy)

MODERNISATION

A contract was signed on 5 May 1989 with HDW and Ferrostaal to implement the Neptun update programme to bring first four up to the same standard as the 'Poseidon' class. The first boat, *Triton,* completed its refit at Kiel, Germany in May 1993, while the remainder are being refitted at Salamis in a Synchrolift purchased by the Greek Navy for the purpose. 25 per cent of the cost is being covered by German Military Aid, which probably explains why the work on one of the four boats was done at Kiel. The programme should be completed in 1997.

The refit work includes modifying the tubes to launch Sub-Harpoon and replacing the flank array sonar, ESM intercept equipment and the fire-control system. In addition, new equipment is being installed, including the Sperry Mk 29 Mod 3 inertial navigation system, Magnavox global positioning system (GPS), Omega and satellite navigation equipment.

SHISHUMAR



Shishumar (Ian Sturton)

GENERAL SPECIFICATIONS

Country: India

Class: SHISHUMAR
Type: 209/1500

Built: 4
In service: 4

Displacement:
surfaced: 1,600 t
submerged: 1,850 t

Dimensions
Length: 64.4 M (211.2 m)
Beam: 6.5 m (21.3 ft)
Draught: 6.0 m (19.7 ft)

Speed:
surfaced: 11 kts
submerged: 22 kts
Range:
surface: 13,000 n miles at 10 kts
snorting: 8,000 n miles at 8 kts
Diving depth: 260 m (853 ft).

Complement: 40 (8 officers)

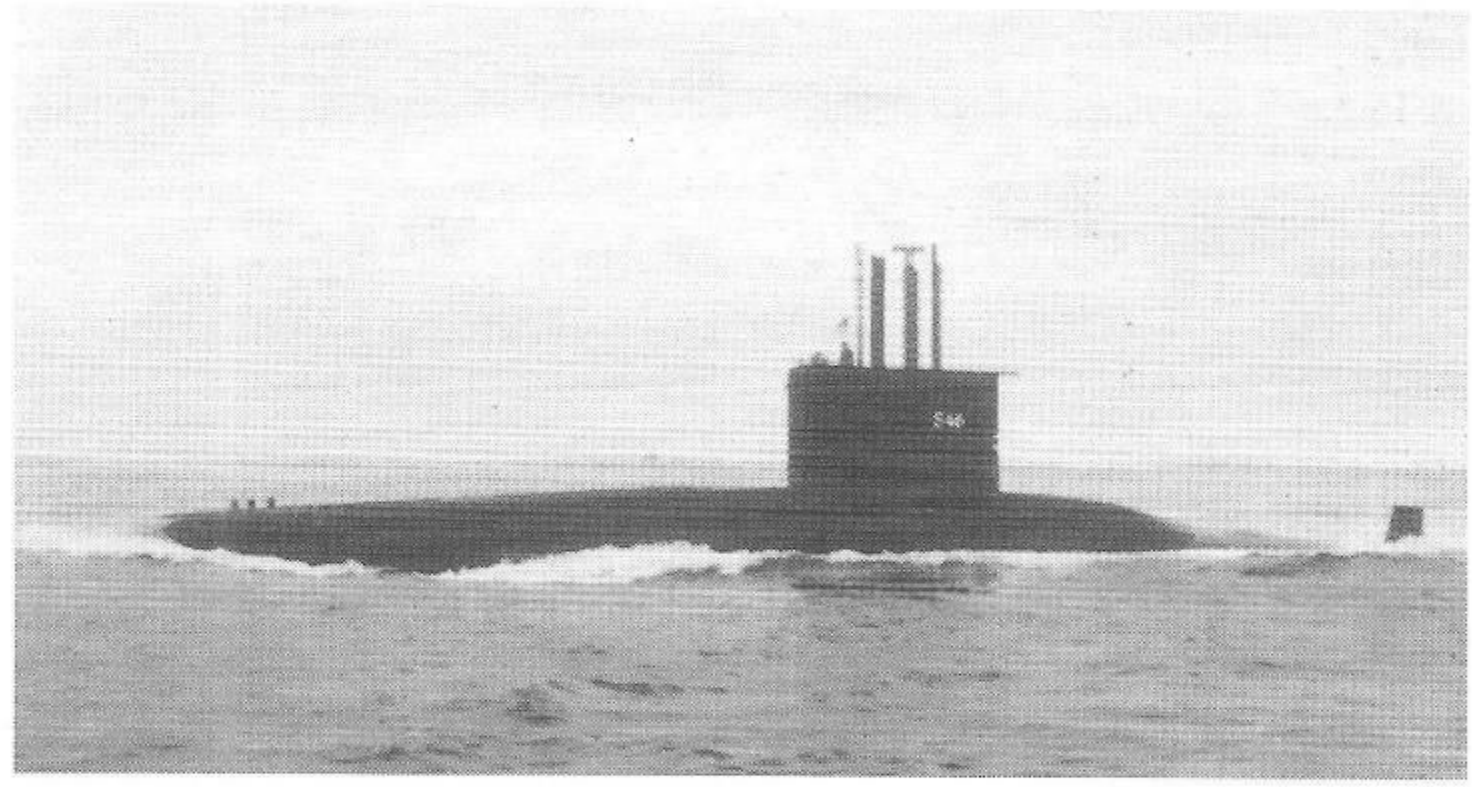
SUBMARINES

SHISHUMAR (S 44)
Builder Howaldtswerke, Kiel, Germany
Laid down 1 May 1982
Launched 13 Dec 1984
Commissioned 22 Sep 1986

SHANKUSH (S 45)
Builder Howaldtswerke, Kiel, Germany
Laid down 1 Sep 1982
Launched 11 May 1984
Commissioned 20 Nov 1986

SHALKI (S 46)
Builder Mazagon Dock Ltd, Bombay, India
Laid down 5 Jun 1984
Launched 30 Sep 1989
Commissioned 7 Feb 1992

SHANKUL (S 47)
Builder Mazagon Dock Ltd, Bombay, India
Laid down 3 Sep 1989
Launched 21 Mar 1992
Commissioned 28 May 1994



Shalki *(S 46), the third Type 209/1500 submarine for the Indian Navy and the first submarine ever to be built in an Indian dockyard* (Mazagon Dock)

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) tubes.
Total weapons carried, 14.

TORPEDOES

STN Atlas SUT Mod 1

SUT (Surface and Underwater Target) is a dual-purpose, wire-guided torpedo for use against both surface and submarine targets. It is electrically propelled and the wire guidance gives immunity to interference with a two-way datalink between vessel and torpedo. The acoustic homing head has long acquisition ranges and a wide search sector for active and passive operation. The large payload with combined fuze systems ensures the optimum effect of explosive power. The SUT operates at great depths as well as in very shallow waters. Consort operation permits exploitation of the full over-the-horizon range of the SUT.

Specifications
Length: 6.15 m (20.18 ft)
Diameter: 533 mm (21 in)
Weight: 1,420 kg (3,130 lb)
Warhead: 260 kg (573 lb)
Speed: Selectable, max 35 kts
Range: 6.5 n miles (12 km) at 35 kts; 15 n miles (28 km) at 23 kts
Fuze: Magnetic, proximity and impact

Manufacturer/Contractor
STN Atlas Elektronik, Bremen/Hamburg, Germany.

MINES

An IKL-designed external 'strap-on' minelaying pod enables each submarine to carry 24 mines in addition to its torpedo load.

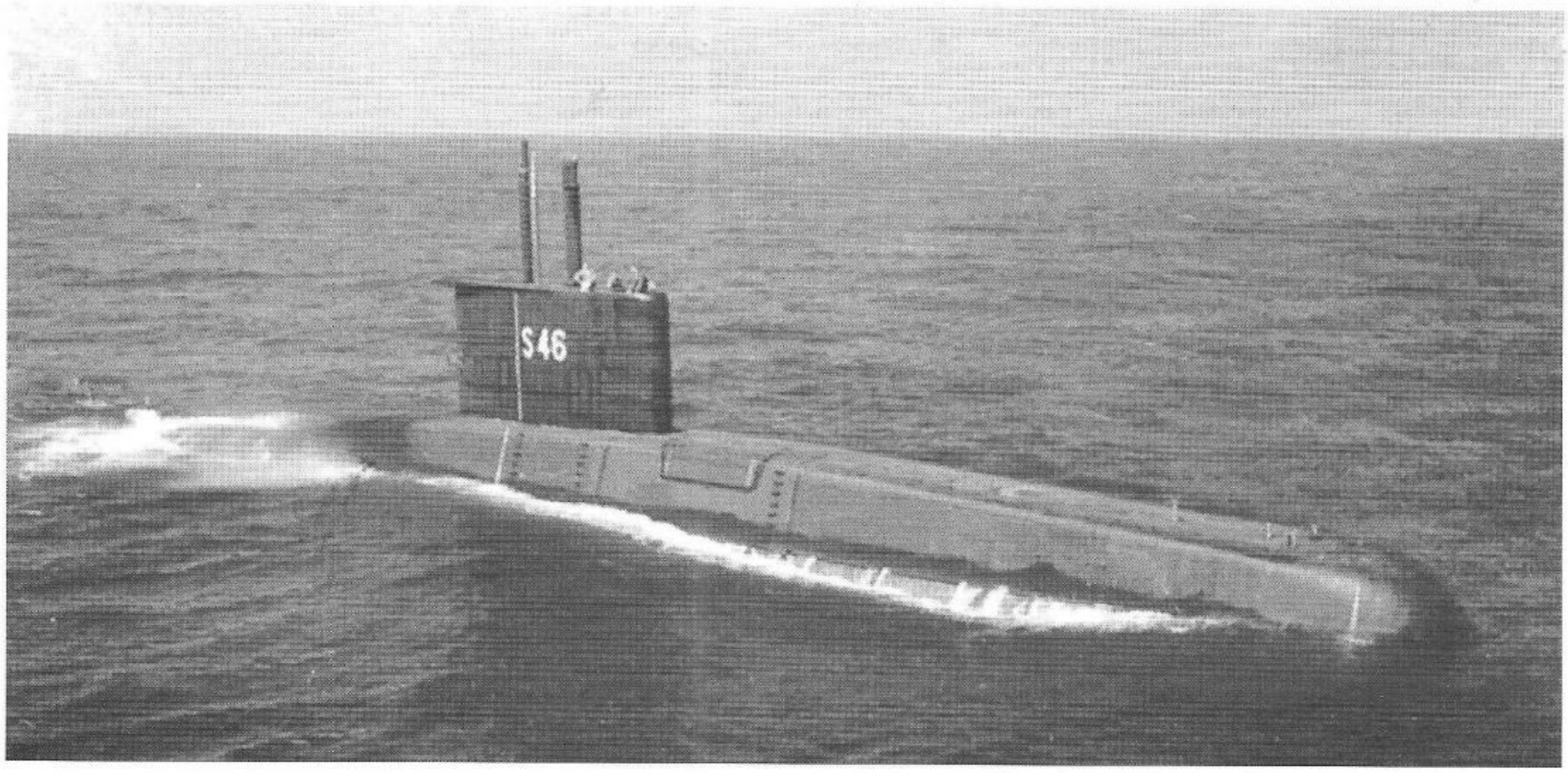
ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

ARGOSystems Phoenix II

Phoenix II is an ESM system designed to provide automatic identification and bearing of intercepted radar emissions in the frequency range 2-18 GHz. The system consists of a combination of omnidirectional, monopulse and directional antenna arrays and a very sensitive IFM receiver. All signal processing and identification is automatic. As far as is known this is the only submarine application of the system to date.

Manufacturer/Contractor
ARGOSystems, Sunnyvale, California, USA.



This picture clearly shows the square outline of the IKL-designed escape sphere located immediately before the sail (Indian Navy)

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Singer Librascope Submarine Fire-Control System Mk 1

SFCS Mk 1 was the first all-digital FCS for submarines and can detect 20 targets, of which four can be tracked simultaneously and two engaged. A high degree of automation means that only three positions are required to be manned: the command position in the control room and two fire-control consoles. The system employs a UYK-20 computer. SFCS Mk 1 was also supplied to Australia and Canada for their 'Oberon' class submarines.

Manufacturer/Contractor
Singer-Librascope, Glendale, California, USA.

RADAR

Kelvin Hughes Type 1007

The Type 1007 is used for navigation and surface search.

Specifications
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 31 dB
Pulsewidth: 0.08/0.35/0.8 µs
Pulse repetition frequency: 1,600/800/400 pps
Scan rate: 26 rpm

Manufacturer/Contractor
Kelvin Hughes, Ilford, Essex, UK.

SONARS

STN Atlas CSU-83/1

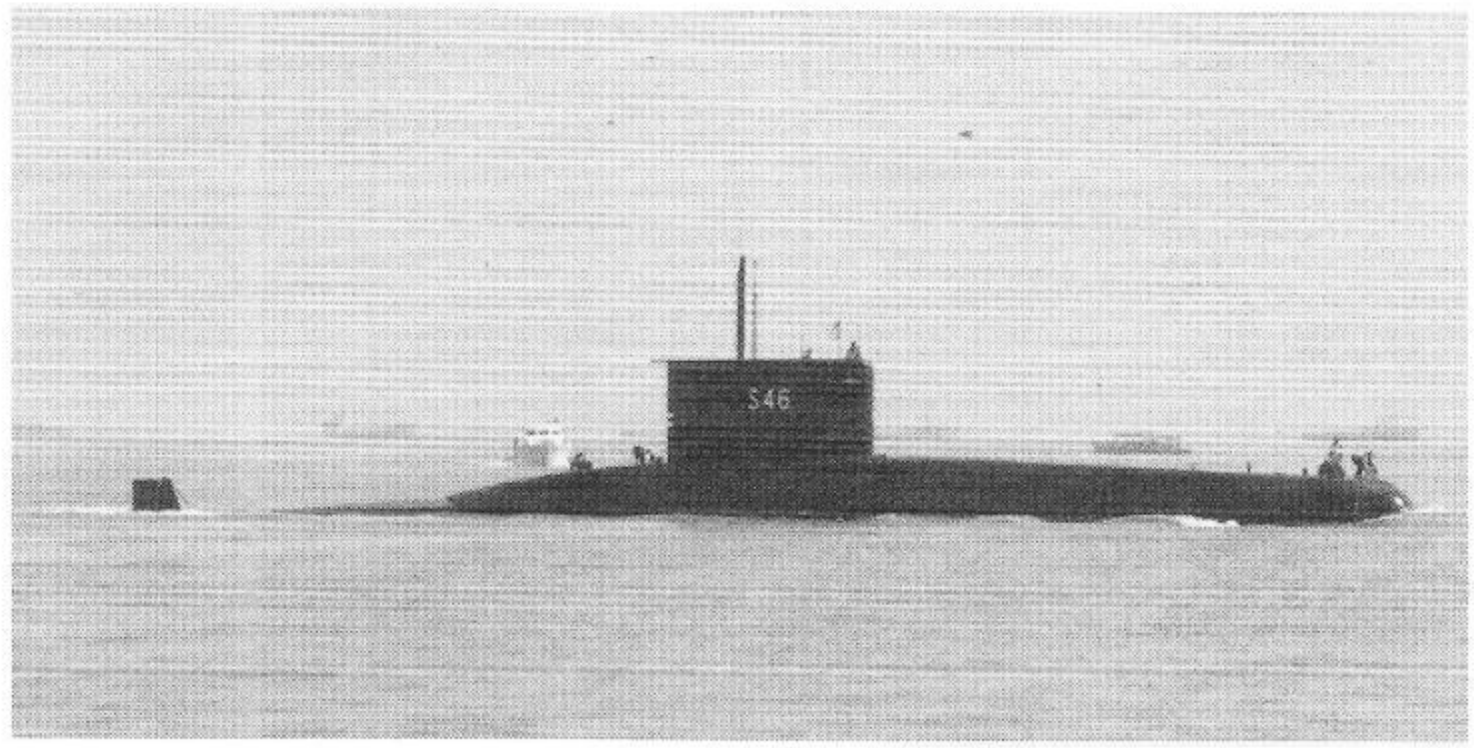
The CSU-83 (DBQS-21) sonar suite is designed for submarines of 400 tonnes displacement and upwards, and is the primary sensor of the submarine fire-control and command system of the German Navy. It comprises a passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array covering the frequencies 10 Hz to 2 kHz, a towed array, and two self-noise detectors. The system is claimed to provide high probability of detection over 360°.

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

Thomson-Sintra DUUX-5 Fenelon

DUUX-5 (also known as Fenelon) is a panoramic sonar capable of automatic, simultaneous tracking of three targets. It incorporates a passive acoustic rangefinder for measuring the range of three targets within 120° sectors, and a panoramic sonar interceptor measuring the true bearing of all sonar transmissions received in the 2-15 kHz band. It enables range and bearing information on targets to be obtained by the submarine without the need for any transmissions and with minimum delay. Speed of operation permits target course and speed to be computed rapidly, also allowing any changes in either speed or course to be detected without delay. Four targets can be tracked simultaneously (three on radiated self-noise, one on sonar pulses), and there is a continuous panoramic bearing display over 360°. Range information is provided over arcs of 120° on each side of the submarine. Target data is automatically transmitted to the ship's weapon control system and plotting table. Under normal conditions, results in the middle sector are 0.3° for bearing accuracy, 2° discrimination accuracy between two targets and 5 per cent of range on radiated noise for a target at 10 km distance. Two types of hydrophones are available. The hydrophonic unit is composed of two bases with three hydrophones each on the starboard and port sides of the submarine. All other technical details remain classified.

Manufacturer/Contractor
Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, France.



Shalki *(S 46)* (H & L van Ginderen Collection)

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 4 MTU 12V 493 AZ80 GA31L; 1.76 MW (2,400 hp(m)) sustained
Alternators: 4—1.8 MW
Electric motor: 1 Siemens; 3.38 MW (4,600 hp(m)) sustained
Shafts: 1
Battery:
S 44, S 45: 4 Varta batteries, each of 132 cells
S 46, S 47: 4 British Chloride batteries, each of 132 cells

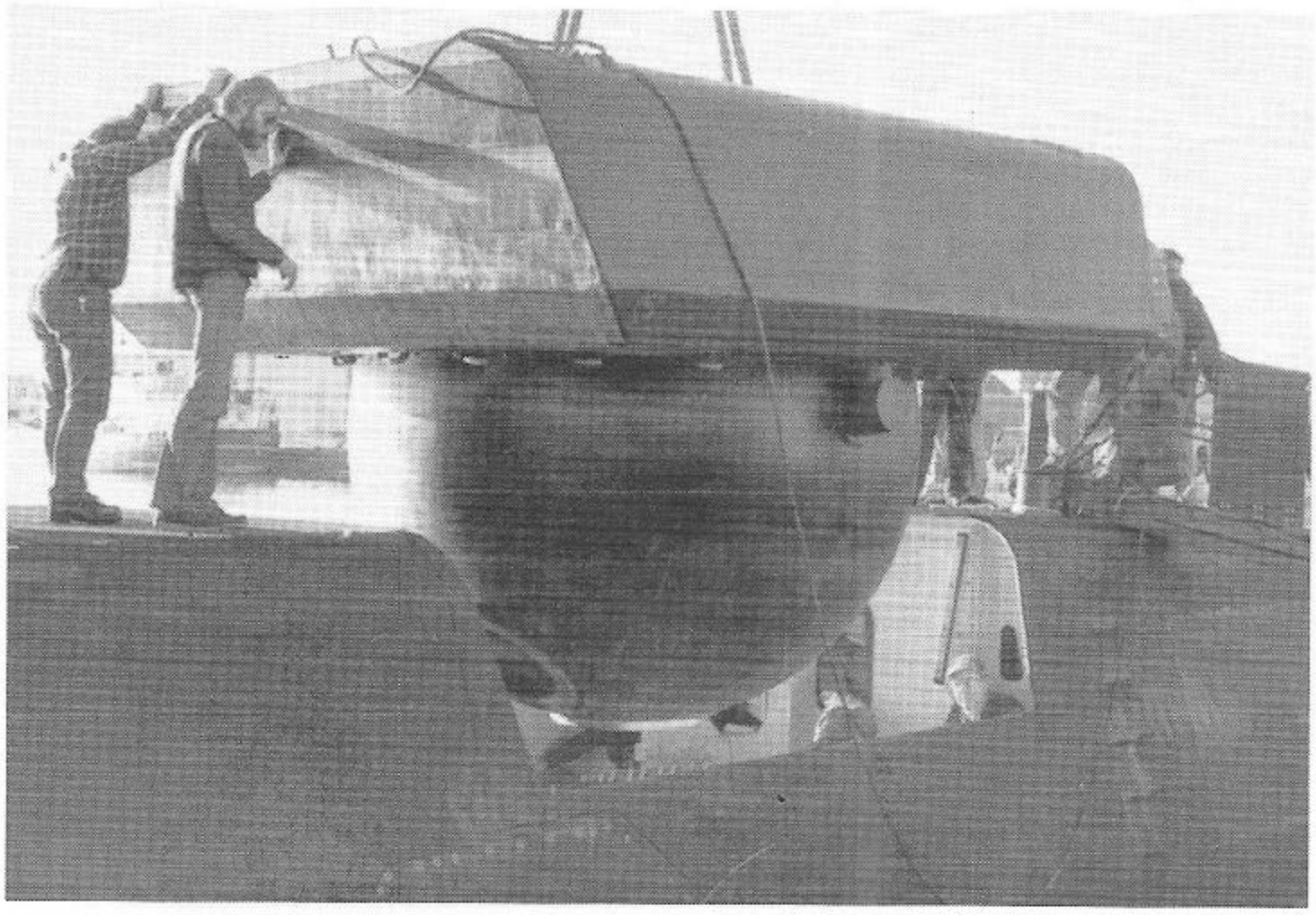
FURTHER INFORMATION

PROGRAMME

There were lengthy negotiations before the contract with India was signed on 11 December 1981. This contract contained five elements: the construction in Germany of two Type 1500 submarines; the supply of 'packages' for the building of two more boats at Mazagon, Bombay; training specialists for the design and construction of the Mazagon pair; logistic services during the trials and early part of the commissions; and consultation services in Bombay. The two German-built boats were laid down in May and August 1972, but they eventually sailed for India together in February 1987.

The third boat was laid down in Mazagon in June 1984, but work was delayed by assembly problems due to faulty welding, a problem by no means unique to the Mazagon yard. In 1984 it was announced that a further two submarines would be built at Mazagon to make a class total of 6 but this was overtaken by events in 1987-88 and the agreement with HDW terminated at four.

The plan was reconsidered in 1992, but the final outcome was that no more of this class would be built.



The escape module is lowered into position. The spherical chamber can accommodate the full crew of 40 and on being released the flotation collar carries the entire device to the surface (HDW)

DESIGN

The Type 1500 pressure hull has a central bulkhead. It also incorporates an IKL-designed, integrated escape sphere, which can carry the full crew of up to 40 men. The sphere, which sits just forward of the sail, has an oxygen supply for eight hours, and can withstand pressures at least as great as those that can be withstood by the submarine's pressure hull.

MODERNISATION

The two boats built in Germany have DUUX-2 sonar, which is being replaced by DUUX-5 in their current refits.

CAKRA

GENERAL SPECIFICATION

Country: Indonesia

Class: CAKRA
Type: 209/1300

Built: 2
In service: 2

Displacement:
surfaced: 1,285 t
submerged: 1,390 t

Dimensions
Length: 59.5 m (195.2 ft)
Beam: 6.2 m (20.3 ft)
Draught: 5.4 m (17.9 ft)

Speed:
surfaced: 11 kts
submerged: 21.5 kts
Diving depth: 240 m (790 ft).
Range: 8,200 n miles at 8 kts
Endurance: 50 days.

Complement: 34 (6 officers)

SUBMARINES

CAKRA (401)

Builder	Howaldtswerke, Kiel, Germany
Laid down	25 Nov 1977
Launched	10 Sep 1980
Commissioned	19 Mar 1981

NANGGALA (402)

Builder	Howaldtswerke, Kiel, Germany
Laid down	14 Mar 1978
Launched	10 Sep 1980
Commissioned	6 Jul 1981

Submarine Cakra *(401) was the first submarine to be operated by the Indonesian Navy* (H & L van Ginderen Collection)

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) bow tubes.
Total weapons load, 14.

TORPEDOES

STN Atlas SUT Mod 0

SUT (Surface and Underwater Target) is a dual-purpose, wire-guided torpedo for use against both surface and submarine targets. It is electrically propelled and the wire guidance gives immunity to interference with a two-way datalink between vessel and torpedo. The acoustic homing head has long acquisition ranges and a wide search sector for active and passive operation. The large payload with combined fuze systems ensures the optimum effect of explosive power. The SUT operates at great depths as well as in very shallow waters. Consort operation permits exploitation of the full over-the-horizon range of the SUT. The SUT is manufactured under licence in Indonesia by IPTN.

Specifications
Length: 6.15 m (20.18 ft)
Diameter: 533 mm (21 in)
Weight: 1,420 kg (3,130 lb)
Warhead: 260 kg (573 lb)
Speed: Selectable, max 35 kts
Range: 6.5 n miles (12 km) at 35 kts; 15 n miles (28 km) at 23 kts
Fuze: Magnetic, proximity and impact

Manufacturer/Contractor
STN Atlas Elektronik, Bremen/Hamburg, Germany.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thomson-CSF DR 2000U

DR 2000U is an F-band ESM and radar warning receiver, designed specifically for submarine applications. The system offers threat warning, surveillance, emitter identification, ELINT, and automatic EW system control capabilities and can also, if required, be interfaced with decoy dispensers or jammers to control their operation. The DR 2000U antenna array consists of an omnidirectional unit for frequency measurements and two concentric sets of six antennas.

Manufacturer/Contractor
Thomson-CSF, Radars and Countermeasures Division, Elancourt, France.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Signaal SINBADS (Submarine INtegrated Battle And Data System)

SINBADS is installed in SS 31 and SS 32, only. SINBADS was developed from M8 and is an integrated command and weapon control system using a federated architecture and consisting of a central processing cabinet, Display and Control Consoles (DaCC), and two weapon electronics cabinets. The weapon electronics cabinets are installed near the torpedo tubes controlling half the weapon launching system and are used to warm up the weapons, preset torpedoes, and provide firing signals to the weapons and launching systems. They perform weapon control and ballistic calculations and guide torpedoes after launch. During surveillance operations one will be switched off to conserve power. The tracking algorithm is based upon Kalman filtering while the tracking system is based upon bearing-only analysis, although it can accept other target data inputs. The system can track

five targets while simultaneously operating three torpedoes.

Manufacturer/Contractor

Hollandse Signaalapparaten BV, Hengelo, Netherlands.

SONAR

STN Atlas CSU 3-2

CSU 3-2 is a fast-scanning medium-range, medium-frequency, active/passive sonar, which can be used as a long-range passive device, an intercept sonar and as an underwater telephone. The equipment has a chin array, with 96 staves arranged in a horseshoe. The PRS-3/4 passive ranging sonar is an integral part of the CSU suite.

Manufacturer/Contractor

STN Atlas Elektronik GmbH, Bremen, Germany.

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 4 MTU 12V 493 AZ80 GA31L diesels; 1.76 MW (2,400 hp(m)) sustained
Alternators: 4 Siemens alternators; 1.7 MW
Electric motor: 1 Siemens motor; 3.38 MW (4,600 hp(m)) sustained
Shaft: 1
Battery: 4 Hagen 120-cell batteries; 11,500 Ah

FURTHER INFORMATION

PROGRAMME

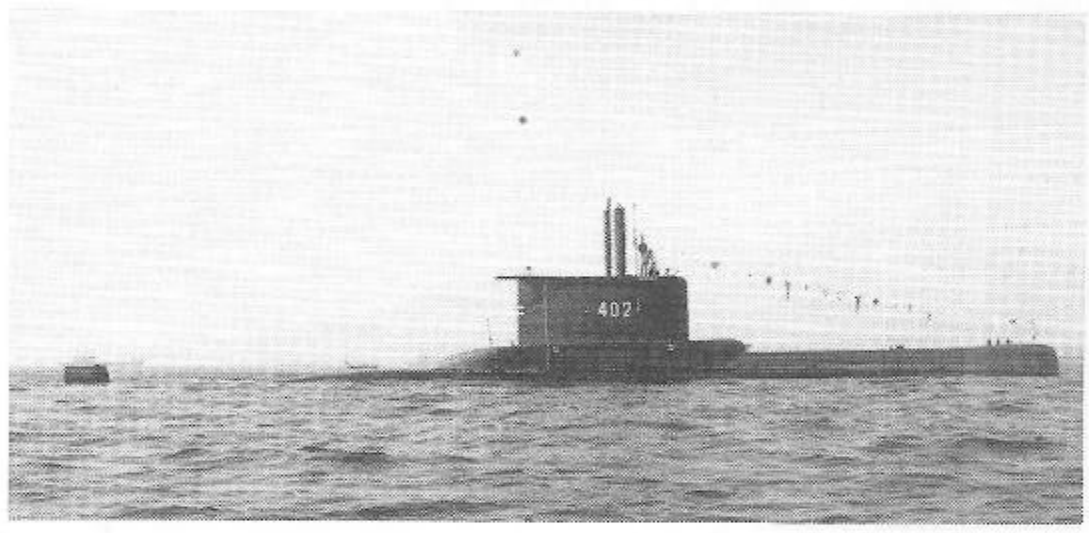
These two submarines were ordered on 2 April 1977.

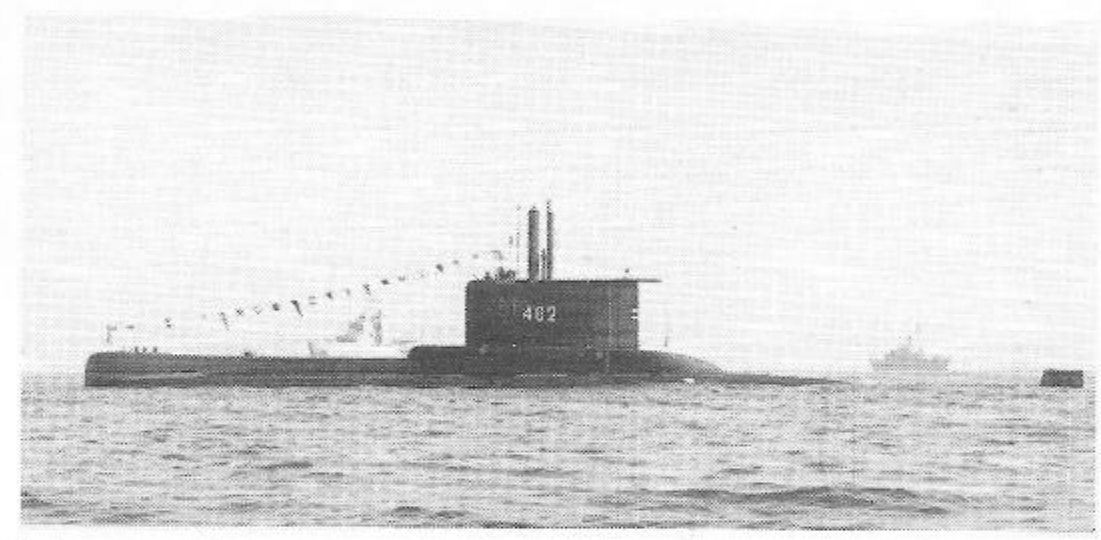
MODERNISATION

These boats underwent major refits at HDW spanning three years from 1986 to 1989. The Indonesians considered these refits to be expensive and lengthy, which may have discouraged further orders at that time. *Cakra* was refitted again at Surabaya 1993-1995, which included replacement batteries and updating the SINBADS fire-control system.

THE FUTURE

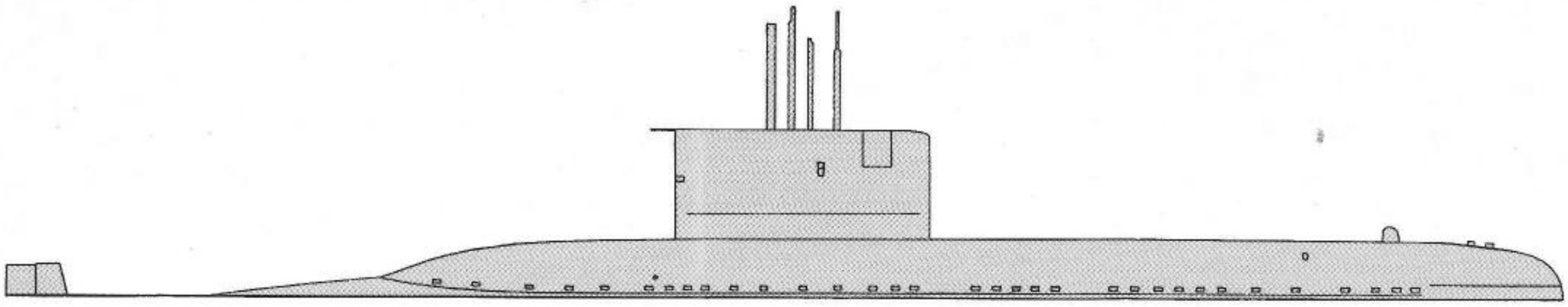
Indonesia has been seeking two more submarines for some years. One strong possibility is two more Type 209s, which would have obvious merits of standardisation and dealing with a known supplier. On the other hand, the Netherlands is known to have offered the two redundant 'Zwaardvis' class submarines, which are available, modern, very capable and relatively cheap, while the Indonesian Navy already operates a number of ex-Dutch ships. Other possibilities are new-build 'Moray' class from the VSEL-RDM partnership and the 'Collins' class from Australia.





Two views of Indonesian submarine Nanggala *(402). The vast Indonesian archipelago contains a number of straits where these submarines could exert an influence out of all proportion to their size* (H & L van Ginderen Collection)

CHANG BOGO



Chang Bogo (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Korea, South

Class: CHANG BOGO
Type: 209/1200

Ordered: 9
In service: 5
Building: 4

Displacement:
surfaced: 1,100 t
submerged: 1,285 t

Dimensions
Length: 56 m (183.7 ft)
Beam: 6.2 m (20.3 ft)
Draught: 5.5 m (18.0 ft)

Speed:
surfaced/snorting: 11 kts
submerged: 22 kts
Range, surfaced: 7,500 n miles at 8 kts

Complement: 33 (6 officers)

SUBMARINES

CHANG BOGO (061)
Builder HDW, Kiel, Germany
Laid down 1989
Launched 18 Jun 1992
Commissioned 14 Oct 1992

YI CHON (062)
Builder Daewoo, Okpo, Korea
Laid down 1990
Launched 14 Oct 1992
Commissioned 30 Apr 1994

CHOI MUSON (063)
Builder Daewoo, Okpo, Korea
Laid down 1991
Launched 25 Aug 1993
Commissioned 27 Feb 1995

PAKUI (065)
Builder Daewoo, Okpo, Korea
Laid down 1992
Launched 20 May 1994
Commissioned Feb 1996

LEE JONGMU (066)
Builder Daewoo, Okpo, Korea
Laid down 1993
Launched 17 Apr 1995
Commissioned Oct 1996

— (067)
Builder Daewoo, Okpo, Korea
Laid down 1994
Launched January 1996
Commissioned June 1997

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) bow tubes; swim-out.
Total weapons carried, 14.

TORPEDOES

STN Atlas SUT Mod 0

SUT (Surface and Underwater Target) is a dual-purpose, wire-guided torpedo for use against both surface and submarine targets. It is electrically propelled and the wire guidance gives immunity to interference with a two-way datalink between vessel and torpedo. The acoustic homing head has long acquisition ranges and a wide search sector for active and passive operation. The large payload with combined fuze systems ensures the optimum effect of explosive power. The SUT operates at great depths as well as in very shallow waters. Consort operation permits exploitation of the full over-the-horizon range of the SUT. Only sufficient SUTs were acquired to outfit three submarines.

Specifications
Length: 6.15 m (20.18 ft)
Diameter: 533 mm (21 in)
Weight: 1,420 kg (3,131 lb)
Warhead: 260 kg (573 lb)
Speed: Selectable, max 35 kts
Range: 6.5 n miles (12 km) at 35 kts; 15 n miles (28 km) at 23 kts
Fuse: Magnetic, proximity and impact

Manufacturer/Contractor
STN Atlas Elektronik, Bremen/Hamburg, Germany.

MINES

28 tube-launched mines in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

ARGOSystems Phoenix II

Phoenix II is an ESM system designed to provide automatic identification and bearing of intercepted radar emissions in the frequency range 2-18 GHz. The system consists of a combination of omnidirectional, monopulse and directional antenna arrays and a very sensitive IFM receiver. All signal processing and identification is automatic. As far as is known this is the only submarine application of the system to date.

Manufacturer/Contractor
ARGOSystems, Sunnyvale, California, USA.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

STN Atlas ISUS, integrated combat system

ISUS is an integrated submarine combat system designed to acquire, process, analyse and display data from all sensors fitted in the boat, and, in particular for the CSU-83 sonar suite. The system integrates a wide variety of acoustic arrays including: cylindrical or conformal; flank; towed; passive ranging; cylindrical transducer; and intercept, as well as own noise hydrophones and accelerometers; Doppler and EM log; underwater telephone; radar; ESM; optic and optronic sensors and navigation sensors. Among the functions performed by the system are: broadband detection over 360°; broadband sonar pulse detection over 360°; detection of low-frequency spectral lines over a long range; transient detection and storage; range measurement in two 120° sectors; navigation, and detection of own hydrodynamic and machinery noise. It also carries out automatic and interactive tracking of targets; audio broadband and narrowband analysis leading to computer-aided classification suggestion; threat analysis; launching suggestion for weapons; integration of the torpedo sonar information from wire-guided torpedoes; launching of Sub-Harpoon; control of wire-guided torpedoes and display of the target/weapon situation.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen, Germany.

RADAR

I-band navigation radar; type not known.

SONAR

STN Atlas CSU-83
The CSU-83 (DBQS-21) sonar suite is designed for submarines of 400 tonnes displacement and upwards, and is the primary sensor of the submarine fire-control and command system of the German Navy. It comprises a passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array covering the frequencies 10 Hz to 2 kHz, a towed array, and two self-noise detectors. The system is claimed to provide high probability of detection over 360°.

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 4 MTU 12V 396 SE diesels; 2.8 MW (3,800 hp(m)) sustained
Alternators: 4 alternators
Electric motor: 1 Siemens; 3.38 MW (4,600 hp(m)) sustained
Shafts: 1
Batteries: 4—120-cell batteries; 11,500 Ah

FURTHER INFORMATION

PROGRAMME

These submarines are the first large boats to be operated by the Republic of Korea (RoK) Navy, although it has operated some mini-subs for several years. The first three were ordered in late 1987, of which one was built at Kiel, Germany by HDW, with key Korean personnel participating, and handed over in Germany on 14 October 1992. The other two were assembled at Okpo by Daewoo from material packages transported from Germany. A second batch of three was ordered in October 1989 and a third batch, also of three, in January 1994.

DESIGN

The first batch of Korean Type 1200 are very similar to those built for the Turkish Navy with a heavy dependence on Atlas Elektronik sensors and STN torpedoes. However, there is a progressively larger Korean content in each boat as it is built.

OPERATIONAL

It is reported that only sufficient SUT Mod 2 torpedoes were ordered to equip the first batch of three and that an indigenous torpedo is under development, based on the Honeywell NP 37. The plan is to split the class between the three Fleets.

THE FUTURE

The total requirement is understood to be for 12 submarines, but it is unlikely that more than nine Type 209/1200 will be built. The final trio of boats is, therefore, likely to be larger and will certainly be built in Korea, and possibly designed there, as well.

CASMA

GENERAL SPECIFICATIONS

Country: Peru

Class: CASMA
Type: 209/1200

Built: 6
In service: 6

Displacement:
surfaced: 1,185 t
submerged: 1,290 t

Dimensions
Length: 56 m (183.7 ft)
Beam: 6.2 m (20.3 ft)
Draught: 5.5 m (17.9 ft)

Speed:
surfaced/snorting: 11 kts
submerged: 21.5 kts
Diving depth: 250 m (820 ft).
Range: 240 n miles at 8 kts
Endurance: 50 days

Complement: 35 (5 officers) (*Islay* and *Arica*); 31 (others)

SUBMARINES

CASMA (SS 31)

Builder	Howaldtswerke, Kiel, Germany
Laid down	15 Jul 1977
Launched	31 Aug 1979
Commissioned	19 Dec 1980

ANTOFAGASTA (SS 32)

Builder	Howaldtswerke, Kiel, Germany
Laid down	3 Oct 1977
Launched	19 Dec 1979
Commissioned	22 May 1981

PISAGUA (SS 33)

Builder	Howaldtswerke, Kiel, Germany
Laid down	15 Aug 1978
Launched	19 Oct 1980
Commissioned	12 Jul 1983

CHIPANA (SS 34)

Builder:	Howaldtswerke, Kiel, Germany
Laid down	1 Nov 1978
Launched	19 May 1981
Commissioned	28 Oct 1982

ISLAY (SS 35)

Builder	Howaldtswerke, Kiel, Germany
Laid down	15 Mar 1971
Launched	11 Oct 1973
Commissioned	29 Aug 1974

ARICA (SS 36)

Builder	Howaldtswerke, Kiel, Germany
Laid down	1 Nov 1971
Launched	5 Apr 1974
Commissioned	21 Jan 1975

Antofagasta *(SS 32)* (H & L van Ginderen Collection)

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) tubes.
Total weapons load, 14.

TORPEDOES

Whitehead A184 torpedoes
The Whitehead A184 is a dual-purpose (surface vessels and submarines) wire-guided torpedo with a 250 kg (551 lb) HBX warhead with magnetic influence and impact fuzes. The weapon is capable of two speeds, 24 and 36 knots and is launched by swimming-out. Commands carried by the guidance wires include: course, depth, acoustic mode (active, passive and combined), enabling range, stratum allowed, speed, impact and influence fuze setting, torpedo stop. Replies from the weapon include: course, distance, depth, acoustic mode, speed, other data on interrogation. The A184 is used in all Italian submarines, but the only export order has been from Peru.

Specifications
Length: 6 m (19.69 ft)
Diameter: 534 mm (21 in)
Weight: 1,265 kg (2,789 lb)
Warhead: 250 kg (551 lb) HBX HE
Propulsion: Electric
Homing: Active/passive
Range: 13.7 n miles (25 km) at 24 kts; 9.2 n miles (17 km) at 38 kts
Speed: 24 or 38 kts

Manufacturer/Contractor
Whitehead SpA, Salviano, Italy.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Intercept
An intercept set is installed, maker not known.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

SEPA Mk 3 fire-control system

The SEPA Mk 3 is installed in all submarines except *Casma* (SS 31) and *Antofagasta* (SS 32). It is a fully integrated submarine command and control system which incorporates the use of microprocessors. System functions include acoustic sensor performance prediction, prediction of counter-detection range, TMA, threat evaluation, target designation, as well as the control of torpedoes and countermeasures. Peru is the only export customer to date.

Manufacturer/Contractor
SEPA, Turin, Italy.

Signaal SINBADS (Submarine INtegrated Battle And Data System)

SINBADS is installed in SS 31 and SS 32, only. SINBADS was developed from M8 (see above) and is an integrated command and weapon control system using a federated architecture and consisting of a central processing cabinet, Display and Control Consoles (DaCC), and two weapon electronics cabinets. The weapon electronics cabinets are installed near the torpedo tubes controlling half the weapon launching system and are used to warm up the weapons, preset torpedoes, and provide firing signals to the weapons and launching systems. They perform weapon control and ballistic calculations and guide torpedoes after launch. During surveillance operations one will be switched off to conserve power. The tracking algorithm is based upon Kalman filtering while the tracking system is based upon bearing-only analysis, although it can accept other target data inputs. The system can track five targets while simultaneously operating three torpedoes.

Manufacturer/Contractor
Hollandse Signaalapparaten BV, Hengelo, Netherlands.

RADAR

Thomson-CSF Calypso II

Calypso II is an I-band radar used for surface and air surveillance and target designation, and also for navigation. The antenna is mounted atop a rotating motor unit, at the head of a non-penetrating periscopic mast. Detection range for a 10 m² airborne target is 16 n miles.

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

SONAR

STN Atlas CSU 3-2

CSU 3-2 is a fast-scanning medium-range, medium-frequency, active/passive sonar, which can be used as a long-range passive device, an intercept sonar and as an underwater telephone. The equipment has a chin array, with 96 staves arranged in a horseshoe. The PRS-3/4 passive ranging sonar is an integral part of the CSU suite.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen, Germany.

NAVIGATION

All have Omega radio navaid receivers.

Pisagua *(SS 33)* (H & L van Ginderen Collection)

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 4 MTU 12V 493 AZ80 GA31L; 1.76 MW (2,400 hp(m)) sustained
Alternators: 4 Siemens; 1.7 MW
Electric motor: 1 Siemens; 3.38 MW (4,600 hp(m)) sustained
Shaft: 1
Battery: 4 batteries, each of 120 cells

FURTHER INFORMATION

PROGRAMME

It should be noted that while its lower pennant number suggests that *Casma* (SS 31) is the oldest in the class, *Islay* (SS 35) and *Arica* (SS 36) were, in fact, the original two submarines to be built for Peru. The boats were ordered in pairs: SS 35 and SS 36 in 1973; SS 31 and SS 32 in 1976; and SS 33 and SS 34 in 1977.

MODERNISATION

While the HDW design enables a wide range of equipment to be installed these are the only Type 209s to have Italian equipment. The SEPA Mk 3 fire-control system was installed from 1986 onwards, replacing the original Signaal M8, while Whitehead A184 torpedoes were supplied in 1990 to replace the German SST-4.

Islay *(SS 35)* (H & L van Ginderen Collection)

ATILAY

GENERAL SPECIFICATIONS

Country: Turkey

Class: ATILAY
Type: 209/1200

Built: 6
In service: 6

Displacement:
surfaced: 980 t
submerged: 1,185 t

Dimensions
Length: 61.2 m (200.8 ft)
Beam: 6.2 m (20.3 ft)
Draught: 5.5 m (17.9 ft)

Speed:
surfaced: 11 kts
submerged: 21 kts
Diving depth: 250 m (820 ft)
Range: 7,500 n miles at 8 kts surfaced
Endurance: 50 days

Complement: 38 (9 officers)

SUBMARINES

ATILAY (S 347)
Builder Howaldtswerke, Kiel, Germany
Laid down 1 Dec 1972
Launched 23 Oct 1974
Commissioned 23 Jul 1975

SALDIRAY (S 348)
Builder Howaldtswerke, Kiel, Germany
Laid down 1 Feb 1973
Launched 14 Feb 1975
Commissioned 21 Oct 1975

BATIRAY (S 349)
Builder Howaldtswerke, Kiel, Germany
Laid down 11 Jun 1975
Launched 24 Oct 1977
Commissioned 20 Jul 1978

YILDIRAY (S 350)
Builder Golcük, Izmit, Turkey
Laid down 1 May 1976
Launched 20 Jul 1979
Commissioned 6 Jan 1981

DOGANAY (S 351)
Builder Golcük, Izmit, Turkey
Laid down 15 Apr 1981
Launched 16 Nov 1983
Commissioned 16 Nov 1984

DOLUNAY (S 352)
Builder Golcük, Izmit, Turkey
Laid down 1 Jul 1985
Launched 22 Jul 1988
Commissioned 1 Aug 1989

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) tubes; swim-out discharge. Total weapon load, 14.

TORPEDOES

STN Atlas SST 4

SST 4 (Special Service Target #4) is a wire-guided, heavyweight, 533 mm (21 in) torpedo for use against surface ships and is essentially an export version of the German Navy's DM2 Seeaal. The 260 kg warhead is in the centre of the weapon with an impact fuze and behind it are the silver-zinc batteries, which are identical to those of the DM2 Seeaal. The torpedo operates at depths between from 4.5 m down to its maximum, with the weapon guided from the launcher submarine until the wire is fully dispensed when the torpedo conducts a passive search; it then uses active homing for the terminal phase or to reacquire the target. The design has been improved over the years, especially in the homing head functions and in the stabilisation and related control system.

Specifications
Length: 6.08 m (19.95 ft) (6.55 m (21.49 ft) with guidance wire dispenser)
Diameter: 533 mm (21 in)
Weight: 1,363 kg (3,004.9 lb)
Warhead: 260 kg (573.2 lb)
Propulsion: Electric
Speed: 23-35 kts
Operating depth: 4.5-460 m (15-1,510 ft)
Range: 6.6 n miles (12 km) at 35 kts; 15.3 n miles (28 km) at 23 kts

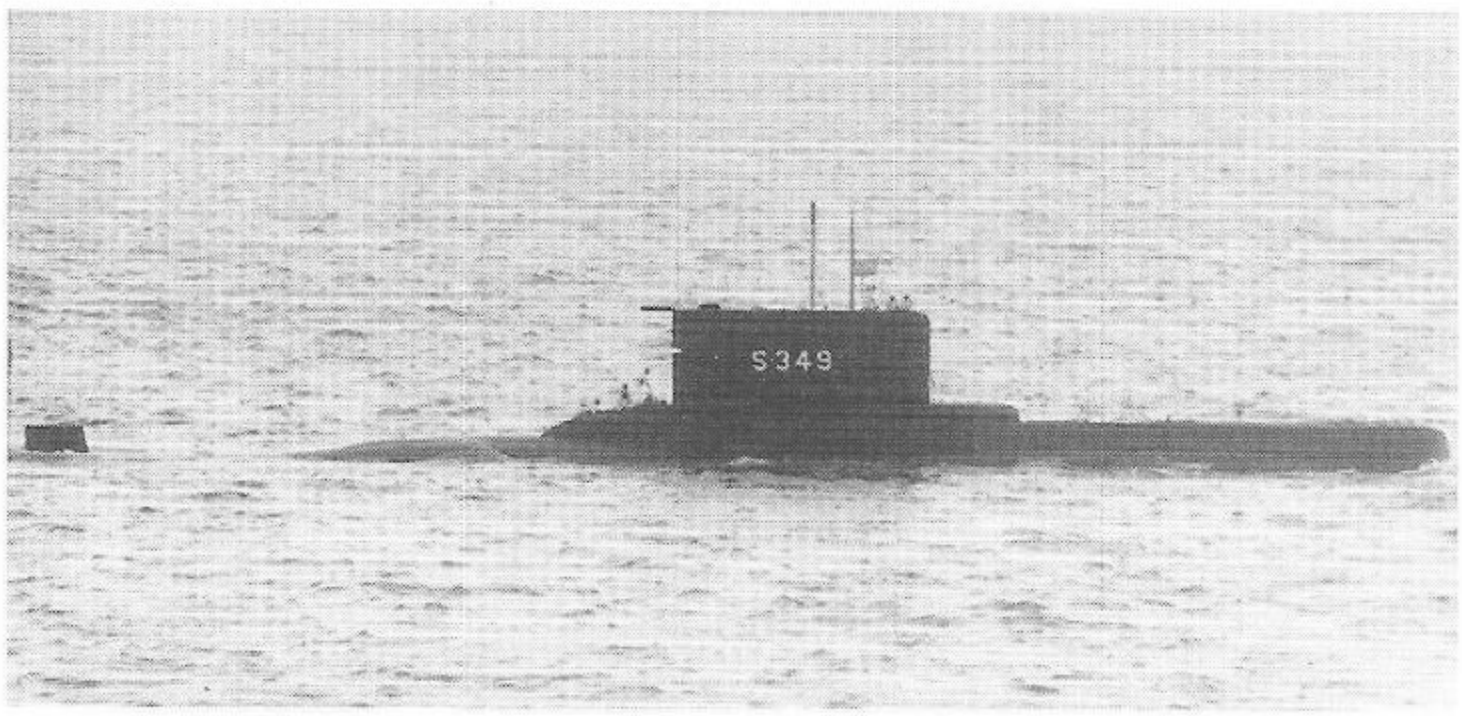
Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

Alliant Mk 37

The Turkish submarines may also carry some Mk 37 torpedoes. The Mk 37 is a 483 mm (19 in) weapon which is launched from 533 mm (21 in) torpedo tubes, swimming-out using guides. Submarine-launched versions are the Mod 0 and Mod 3, (an updated Mod 0), which are both free-running torpedoes which are launched on a target interception course which is maintained until, at a preset range, it initiates a process which arms the warhead and switches in the attack logic circuits. Acquisition takes place at a distance of some 215 m.

Specifications
Length: 3.52 m (11.54 ft)
Diameter: 483 mm (19 in)
Weight: 645 kg (1,422 lb)
Warhead: 150 kg HBX-3 (HE) (331 lb)
Speed: 24 kts (Mod 3)
Range: 11.5 n miles (21.5 km)
Max operating depth: 270 m (886 ft)

Manufacturer/Contractor
Alliant Techsystems, Marine Systems, Hopkins, Minnesota, USA.



Batiray *(S 349)* (Selim San)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thomson-CSF Calypso II

Calypso II is fitted in the first two hulls only; that is, S 347 and S 348. It is an I-band radar used for surface and air surveillance and target designation, and also for navigation. The antenna is mounted atop a rotating motor unit, at the head of a non-penetrating periscopic mast. Detection range for a 10 m^2 airborne target is 16 n miles.

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

Racal Porpoise

The Porpoise system is fitted in S 349 to S 352 (both inclusive). Porpoise is a fully automatic ESM system which receives signals, measures their parameters, and compares these with those contained in a radar threat library. The system is integrated with the vessel's fire-control and communications systems and with

periscope-mounted radar warning equipments. Porpoise gives an alert warning when prime threats, such as helicopter or maritime surveillance radars, reach a preprogrammed danger level. The Porpoise antenna is a compact six port system giving good bearing accuracy and may be mounted on either hull penetrating or non-hull penetrating masts. It is built of titanium to reduce weight and overcome corrosion, and is pressure resistant to 60 bar.

Specifications
Frequency range: 2-18 GHz
Azimuth coverage: *360°*
DF accuracy: 5° RMS
Dynamic range: 60 dB
Library: Up to 2,000 emitter modes

Manufacturer/Contractor
Racal Radar Defence Systems Ltd, Chessington, UK.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Signaal M8/24
M8 is fitted in S 347 and S 348 only; the remainder have SINBADS (see below). M8 is a digital computer-based, fire-control system which is standard fitting in all HDW submarines. The system accepts target data inputs from a range of sensors including radar, active sonar, passive sound detection systems, periscope observation, consort reports and ship's own navigational data. The display has range scale settings for 20, 10 and 5 km, presenting the positions of all contacts from all sensors simultaneously. One or more sensors may be connected to the computer for torpedo engagement, and up to three targets may be attacked simultaneously. The computer is programmed to provide firing data for wire-guided, programmed, conventional, and other types of torpedo, and performs automatic calculation of target position, course and speed. The CRT display can give true motion, relative motion or off-centred presentation of the tactical situation.

Manufacturer/Contractor
Hollandse Signaalapparaten BV, Hengelo, Netherlands.

Signaal SINBADS
SINBADS (Submarine INtegrated Battle And Data System) is installed in S 349 to S 352, both inclusive. SINBADS was developed from M8 (see above) and is an integrated command and weapon control system using a federated architecture and consisting of a central processing cabinet, Display and Control Consoles (DaCC), and two weapon electronics cabinets. The weapon electronics cabinets are installed near the torpedo tubes controlling half the weapon launching system and are used to warm up the weapons, preset torpedoes, and provide firing signals to the weapons and launching systems. They perform weapon control and ballistic calculations and guide torpedoes after launch. During surveillance operations one will be switched off to conserve power. The tracking algorithm is based upon Kalman filtering while the tracking system is based upon bearing-only analysis, although it can accept other target data inputs. The system can track five targets while simultaneously operating three torpedoes. It may also be used with Harpoon missiles.

Manufacturer/Contractor
Hollandse Signaalapparaten BV, Hengelo, Netherlands.

Saldiray *(S 348)* (H & L van Ginderen Collection)

RADAR

S63B
Surface search; I band.

SONARS

STN Atlas CSU 3
CSU 3 is a fast-scanning medium-range, medium-frequency, active/passive sonar, which can be used as a long-range passive device, an intercept sonar and as an underwater telephone. The equipment has a cylindrical transducer array 0.9 m (2.95 ft) high and 3.0 m (9.8 ft) in diameter with electronic beam-steering and is equipped with automatic interference suppression against acoustic countermeasures. CSU 3 is able to track four targets simultaneously.

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

PERISCOPES

Two Kollmorgen periscopes.

Manufacturer/Contractor
Kollmorgen Electro Optical, Northampton, Massachussets, USA.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 4 MTU 12V 493 TY60; 1.76 MW (2,400 hp(m)) sustained
Alternators: 4—1.7 MW
Electric motors: 1 Siemens; 3.38 MW (4,600 hp(m)) sustained
Shaft: 1
Battery: 4—120-cell Hagen batteries; 11,500 Ah

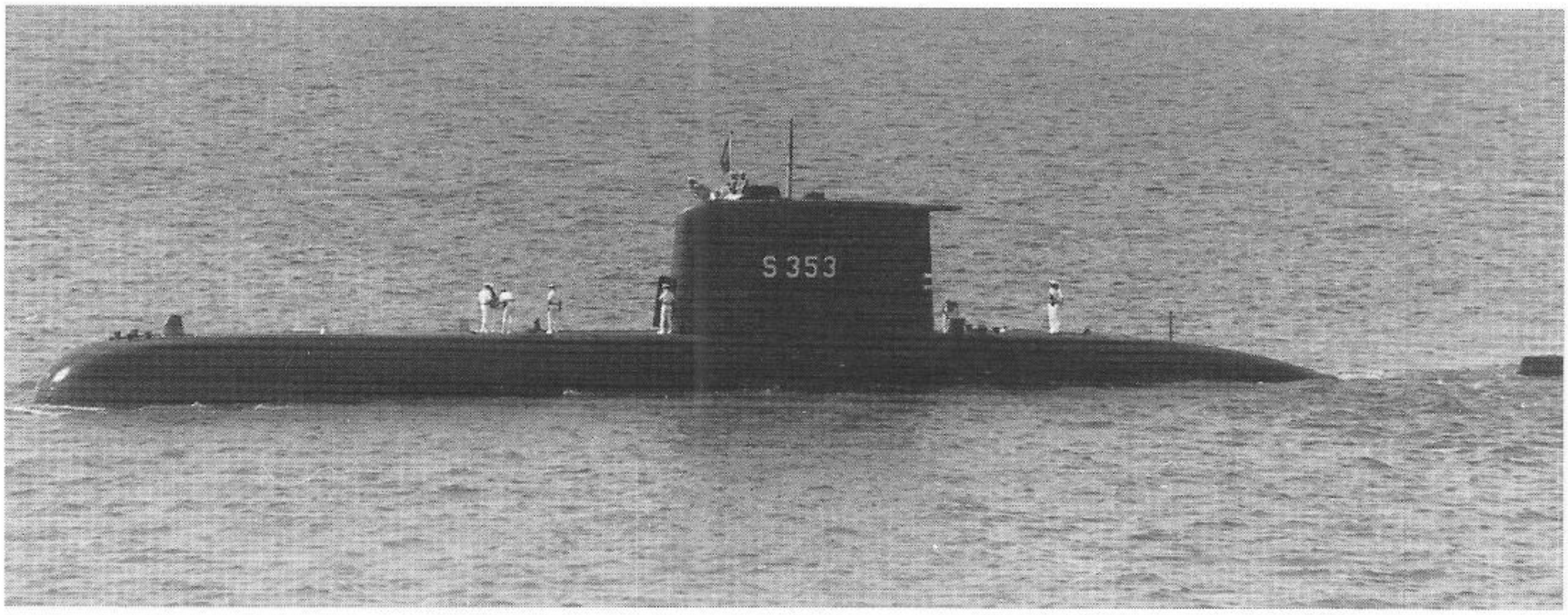
FURTHER INFORMATION

PROGRAMME
The Turkish Navy had been operating a sizeable force of ex-US Navy World War Two submarines for some years but when, in the late 1960s, they decided to purchase modern submarines, one of the criteria was that the deal must include technology transfer. Their plan at that stage was for 12 submarines — a sufficiently sizeable order to justify setting up the submarine facility within the Gölcük yard.

The first three were built at HDW, Kiel, Germany, with Turkish technicians and artificers under training and three of the planned nine were then built at Gölcük, with technical help from HDW. The class was, however, stopped at six boats, but only because it had been decided to build larger Type 209/1400s (see below).

MODERNISATION
It is planned to give these boats a mid-life update, starting with the first pair, which will include a new fire-control system.

PREVEZE



Preveze *(S 353)* (Selim San)

GENERAL SPECIFICATIONS

Country: Turkey

Class: PREVEZE
Type: 209/1400

In service: 2
Building: 2

Displacement:
surfaced: 1,454 t
submerged: 1,586 t

Dimensions
Length: 62 m (203.4 ft)
Beam: 6.2 m (20.3 ft)
Draught: 5.5 m (18 ft)

Speed:
surfaced/snorting: 15 kts
submerged: 21.5 kts
Diving depth: 280 m (820 ft)

Range:
surfaced: 8,200 n miles at 8 kts
submerged: 400 n miles at 4 kts
Endurance: 50 days

Complement: 30

SUBMARINES

PREVEZE (S 353)
Builder Golcük, Kocaeli, Turkey
Laid down 12 Sep 1989
Launched 22 Oct 1993
Commissioned 28 Jul 1994

SAKARYA (S 354)
Builder Golcük, Kocaeli, Turkey
Laid down 1 Feb 1990
Launched 28 Jul 1994
Commissioned Mar 1995

18 MART (S 355)
Builder Golcük, Kocaeli, Turkey
Laid down 28 Jul 1994
Launched Nov 1997
Commissioned 1998

ANAFARTALAR (S 356)
Builder Golcük, Kocaeli, Turkey
Laid down 28 Jul 1994
Launched May 1998
Commissioned 1999

WEAPONS SYSTEMS

ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Sub-Harpoon

The 'Preveze' class boats are fitted during construction, to launch Sub-Harpoon which may be either Block 1B or Block 1C versions. Block 1C has a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three pre-selected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

Eight 533 mm (21 in) bow tubes; four adapted to launch Sub-Harpoon missiles.
Total weapon load, 14 torpedoes/missiles.

TORPEDOES

GEC-Marconi Tigerfish Mk 24 Mod 2

Tigerfish uses the passive mode whenever possible, with the interrogation rate being progressively increased as the torpedo nears the target to improve system accuracy. The onboard computer performs several functions during the attack, including interrogation control, sonar data computation, torpedo steering control and data transmission to the submarine to update its computer memory. The onboard computer is connected through the guidance wire to the submarine's torpedo fire-control computer. During the wire guidance phase the torpedo's computer responds to the demands of the submarine computer, with wire being dispensed from both torpedo and submarine to avoid any stress due to their relative motion. Wire guidance ceases at the point where the torpedo's automatic three-dimensional passive/active acoustic homing system can control the final run to the target and during this phase the torpedo computer interprets data from the homing system sensors to calculate and then command the appropriate course, subject to a priority overriding steer-off azimuth control from the submarine.

Specifications
Length: 6.46 m (21.19 ft)
Diameter: 533 mm (21 in)
Weight: 1,550 kg (3,417 lb) (in air)
Propulsion: Electrically driven contrarotating propellers
Speed: 24 kts (passive), 35 kts (active)
Range:
active homing: 7 n miles (13 km) at 35 kts
passive homing: 15.7 n miles (29 km) at 24 kts
Max operating depth: 610 m (2,000 ft) (estimated)
Warhead: Royal Ordnance 134 kg (295 lb) PBXN 105 warhead
Fuze: Dual-action impact (inertia-type) and proximity (magnetic)
Power: 2 Chloride silver-zinc oxide batteries driving a 2-speed electric motor
Propellers: 2, contrarotating

Manufacturer/Contractor
GEC-Marconi Underwater Weapons Systems Ltd, Waterlooville, Hampshire, UK.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Racal Porpoise
Porpoise is a fully automatic ESM system which receives signals, measures their parameters, and compares these with those contained in a radar threat library. The system is integrated with the vessel's fire-control and communications systems and with periscope-mounted radar warning equipments. Porpoise gives an alert warning when prime threats, such as helicopter or maritime surveillance radars, reach a preprogrammed danger level. The Porpoise antenna is a compact six port system giving good bearing accuracy and may be mounted on either hull-penetrating or non-hull penetrating masts. It is built of titanium to reduce weight and overcome corrosion, and is pressure resistant to 60 bar.

Specifications
Frequency range: 2-18 GHz
Azimuth coverage: 360°
DF accuracy: 5° RMS
Dynamic range: 60 dB
Library: Up to 2,000 emitter modes

Manufacturer/Contractor
Racal Radar Defence Systems Ltd, Chessington, UK.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

STN Atlas ISUS, integrated combat system
ISUS is an integrated submarine combat system designed to acquire, process, analyse and display data from all sensors fitted in the boat, and, in particular for the CSU-83 sonar suite. The system integrates a wide variety of acoustic arrays including: cylindrical or conformal; flank; towed; passive ranging; cylindrical transducer; and intercept, as well as own noise hydrophones and accelerometers; Doppler and EM log; underwater telephone; radar; ESM; optic and optronic sensors and navigation sensors. Among the functions performed by the system are: broadband detection over 360°; broadband sonar pulse detection over 360°; detection of low-frequency spectral lines over a long range; transient detection and storage; range measurement in two 120° sectors; navigation, and detection of own hydrodynamic and machinery noise. It also carries out automatic and interactive tracking of targets; audio broadband and narrowband analysis leading to computer-aided classification suggestion; threat analysis; launching suggestion for weapons; integration of the torpedo sonar information from wire-guided torpedoes; launching of Sub-Harpoon; control of wire-guided torpedoes and display of the target/weapon situation.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen, Germany.

RADAR

The 'Preveze' class is fitted with an I-band surface search radar, but the make is not known.

SONARS

STN Atlas CSU-83/1
The CSU-83 (DBQS-21) sonar suite is designed for submarines of 400 tonnes displacement and upwards, and is the primary sensor of the submarine fire-control and command system of the German Navy. It comprises a passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array covering the frequencies 10 Hz to 2 kHz, a towed array, and two self-noise detectors. The system is claimed to provide high probability of detection over 360°.

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

PERISCOPES

Two Kollmorgen masts are fitted.

Manufacturer/Contractor
Kollmorgen Electro Optical, Northampton, Massachussets, USA.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 4 MTU 12V 396 SB83; 2.8 MW (3,800 hp(m)) sustained
Alternators: 4
Electric motor: 1 Siemens; 3.38 MW (4,000 hp(m)) sustained
Shafts: 1
Battery: 2—240-cell

FURTHER INFORMATION

PROGRAMME

The success of the 'Atilay' class programme led the Turkish Navy to order a larger successor, cancelling the last three Atilays as they did so. The order for first two was signed in Ankara on 17 November 1987 and the option on a further pair was taken up in 1993. As with the last three 'Atilay' class, they are being built at the Gölcük naval yard in Turkey, with assistance from HDW.

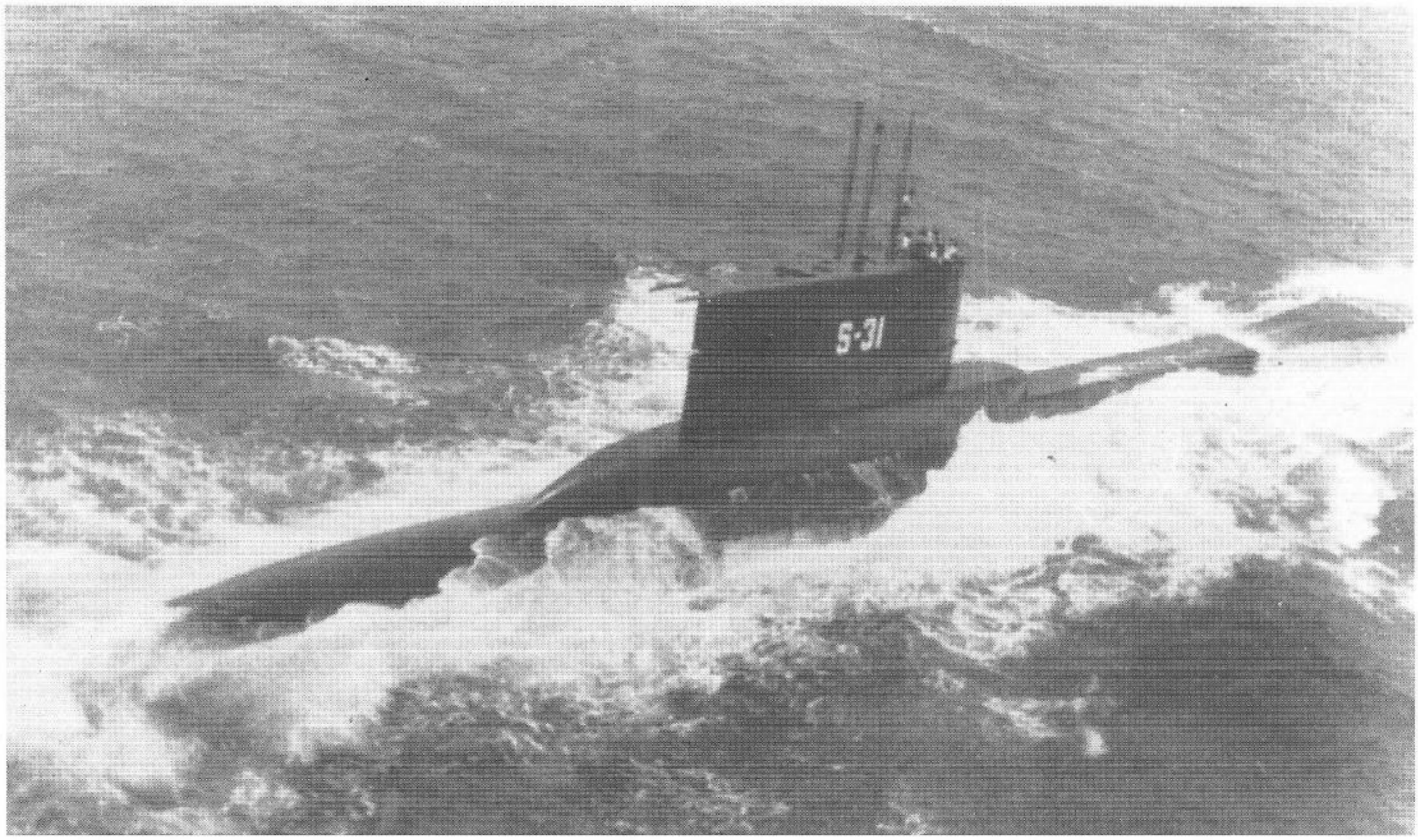
DESIGN

The 'Preveze' class submarines are 2.6 m (8.53 ft) longer than the earlier class and have rather more advanced electronics. Most significantly, however, they are able to launch both Sub-Harpoon missiles and Tigerfish Mk 24 Mod 2 torpedoes, giving them considerably more hitting power.

NAMES

The names commemorate Turkish victories. *18 Mart* (18 March) marks a victory in the Dardanelles campaign in 1915, while *Anafartalar* is a hill in the Gallipoli peninsula.

SABALO



Sabalo *(S 31)* (Venezuelan Navy)

GENERAL SPECIFICATIONS

Country: Venezuela

Class: SABALO
Type: 209/1300

Built: 2
In service: 2
Planned: 2?

Displacement:
surfaced: 1,285 t
submerged: 1,600 t

Dimensions
Length: 61.2 m (200.1 ft)
Beam: 6.2 m (20.3 ft)
Draught: 5.5 m (18 ft)

Speed:
surfaced: 10 kts
submerged: 22 kts
Diving depth: 250 m (820 ft)
Range, surfaced: 7,500 n miles at 10 kts
Endurance: 50 days patrol

Complement: 33 (5 officers)

SUBMARINES

SABALO (S 31 (ex-S 21))

Builder	Howaldtswerke, Kiel, Germany
Laid down	2 May 1973
Launched	1 Jul 1975
Commissioned	6 Aug 1976

CARIBE (S 32 (ex-S 22))

Builder	Howaldtswerke, Kiel, Germany
Laid down	1 Aug 1973
Launched	6 Nov 1975
Commissioned	11 Mar 1977

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) bow tubes; swim-out discharge. Total weapon load, 14.

TORPEDOES

STN Atlas SST 4

SST 4 (Special Service Target #4) is a wire-guided, heavyweight, 533 mm (21 in) torpedo for use against surface ships and is essentially an export version of the German Navy's DM2 Seeaal. The 260 kg warhead is in the centre of the weapon with an impact fuze and behind it are the silver-zinc batteries, which are identical to those of the DM2 Seeaal. The torpedo operates at depths between 4.5 and 460 m with the weapon guided from the launcher submarine until the wire is fully dispensed when the torpedo conducts a passive search; it then uses active homing for the terminal phase or to re-acquire the target. The design has been improved over the years, especially in the homing head functions and in the stabilisation and related control system.

Specifications
Length: 6.08 m (19.95 ft)
Diameter: 533 mm (21 in)
Weight: 1,363 kg (3,005 lb)
Warhead: 260 kg (573 lb)
Propulsion: Electric
Speed: 23-35 kts
Range: 6.6 n miles (12 km) at 35 kts; 15.3 n miles (28 km) at 23 kts
Operating depth: 4.5-460 m (10-1,000 ft)

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

Alliant Mk 37

The Venezuelan submarines may also carry some Mk 37 torpedoes. The Mk 37 is a 483 mm (19 in) weapon which is launched from 533 mm (21 in) torpedo tubes, swimming-out using guides. Submarine-launched versions are the Mod 0 and Mod 3, (an updated Mod 0), which are both free-running torpedoes which are launched on a target interception course which is maintained until, at a preset range, it initiates a process which arms the warhead and switches in the attack logic circuits. Acquisition takes place at a distance of some 215 m.

Specifications
Length: 3.52 m (11.55 ft)
Diameter: 483 mm (19 in)
Weight: 645 kg (1,422 lb)
Warhead: 150 kg HBX-3 (HE) (331 lb)
Speed: 24 kts
Range: 11.5 n miles (21.5 km)
Max operating depth: 270 m (886 ft)

Manufacturer/Contractor
Alliant Techsystems, Marine Systems, Hopkins, Minnesota, USA.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thomson-CSF DR 2000U

DR 2000U is an F-band ESM and radar warning receiver, designed specifically for submarine applications. The system offers threat warning, surveillance, emitter identification, ELINT, and automatic EW system control capabilities and can also, if required, be interfaced with decoy dispensers or jammers to control their operation. The DR 2000U antenna array consists of an omnidirectional unit for frequency measurements and two concentric sets of six antennas.

Manufacturer/Contractor
Thomson-CSF, Radars and Countermeasures Division, Elancourt, France.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

STN Atlas ISUS, integrated combat system

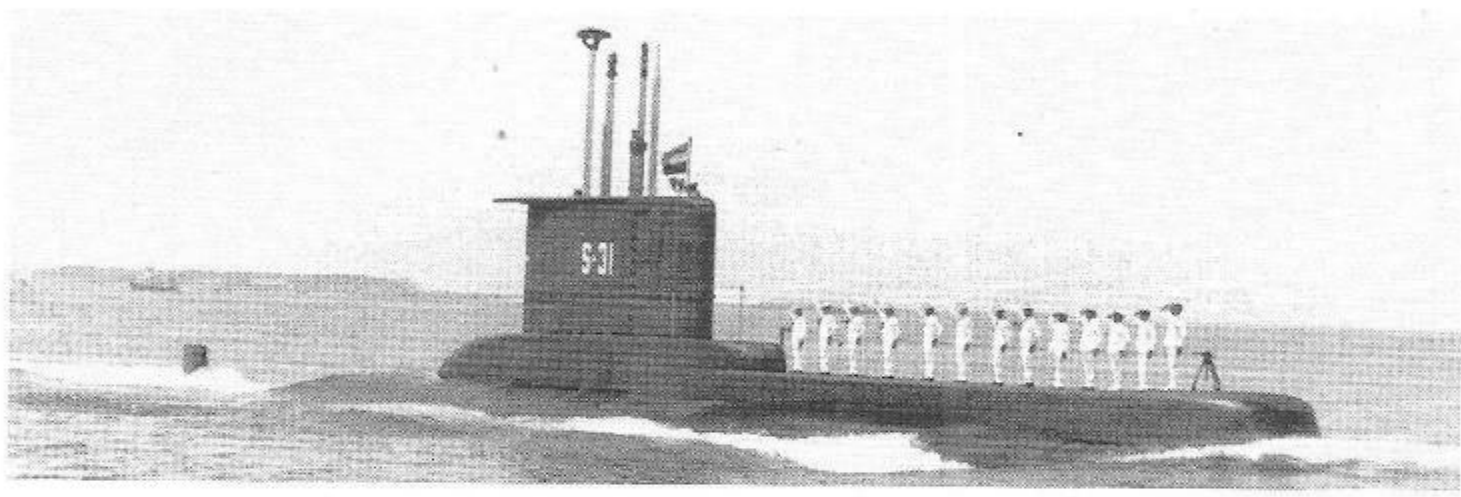
ISUS is an integrated submarine combat system designed to acquire, process, analyse and display data from all sensors fitted in the boat, and, in particular for the CSU-83 sonar suite. The system integrates a wide variety of acoustic arrays including: cylindrical or conformal; flank; towed; passive ranging; cylindrical transducer; and intercept, as well as own noise hydrophones and accelerometers; Doppler and EM log; underwater telephone; radar; ESM; optic and optronic sensors and navigation sensors. Among the functions performed by the system are: broadband detection over 360°; broadband sonar pulse detection over 360°; detection of low-frequency spectral lines over a long range; transient detection and storage; range measurement in two 120° sectors; navigation, and detection of own hydrodynamic and machinery noise. It also carries out automatic and interactive tracking of targets; audio broadband and narrowband analysis leading to computer-aided classification suggestion; threat analysis; launching suggestion for weapons; integration of the torpedo sonar information from wire-guided torpedoes; launching of Sub-Harpoon; control of wire-guided torpedoes and display of the target/weapon situation.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen, Germany.

RADARS

Terma Skanter Mil radar

A Terma Skanter Mil navigation and surface search radar has been fitted in the recent refit.



Sabalo *(S 31)* (Venezuelan Navy)

Specifications
Band: I/J
Beamwidth: <2 × 20° ±1°
Gain: >28.5 dB
Scan rate: Up to 30 rpm
Pulsewidth: 0.06 ± 0/01 µs; or 0.6 ± 0.1 µs
Peak power: 20 kW

Manufacturer/Contractor
Terma Elektronik, Lystrup, Denmark.

SONARS

STN Atlas CSU 3-2

CSU 3-2 is a fast-scanning medium-range, medium-frequency, active/passive sonar, which can be used as a long-range passive device, an intercept sonar and as an underwater telephone. The equipment has a chin array, with 96 staves arranged in a horseshoe. The Ecuadorean Type 209s include a DUUX-2 passive ranging suite.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen, Germany.

Thomson-CSF DUUX-2

DUUX-2 is a passive ranging system, with three transducers each side of the submarine, operating at 5, 7, 12, and 18 kHz. The system covers a 90° arc on each side, with a range accuracy of: 1-5 km — 1 per cent; 5-10 km — 2.5 per cent; 10-20 km — 5 per cent; and 20-30 km — 10 per cent.

PROPULSION

Specifications
System: Diesel-electric

Main Machinery: 4 MTU 12V 493 AZ80 GA31L; 1.76 MW (2,400 hp(m)) sustained
Alternators: 4—1.7 MW

Electric motor: 1 Siemens; 3.38 MW (4,600 hp(m)) sustained
Shafts: 1

FURTHER INFORMATION

PROGRAMME

The Venezuelan Navy originally planned to procure four submarines, but financial considerations limited this to two. The two submarines were ordered in 1971 and delivered in 1976/77.

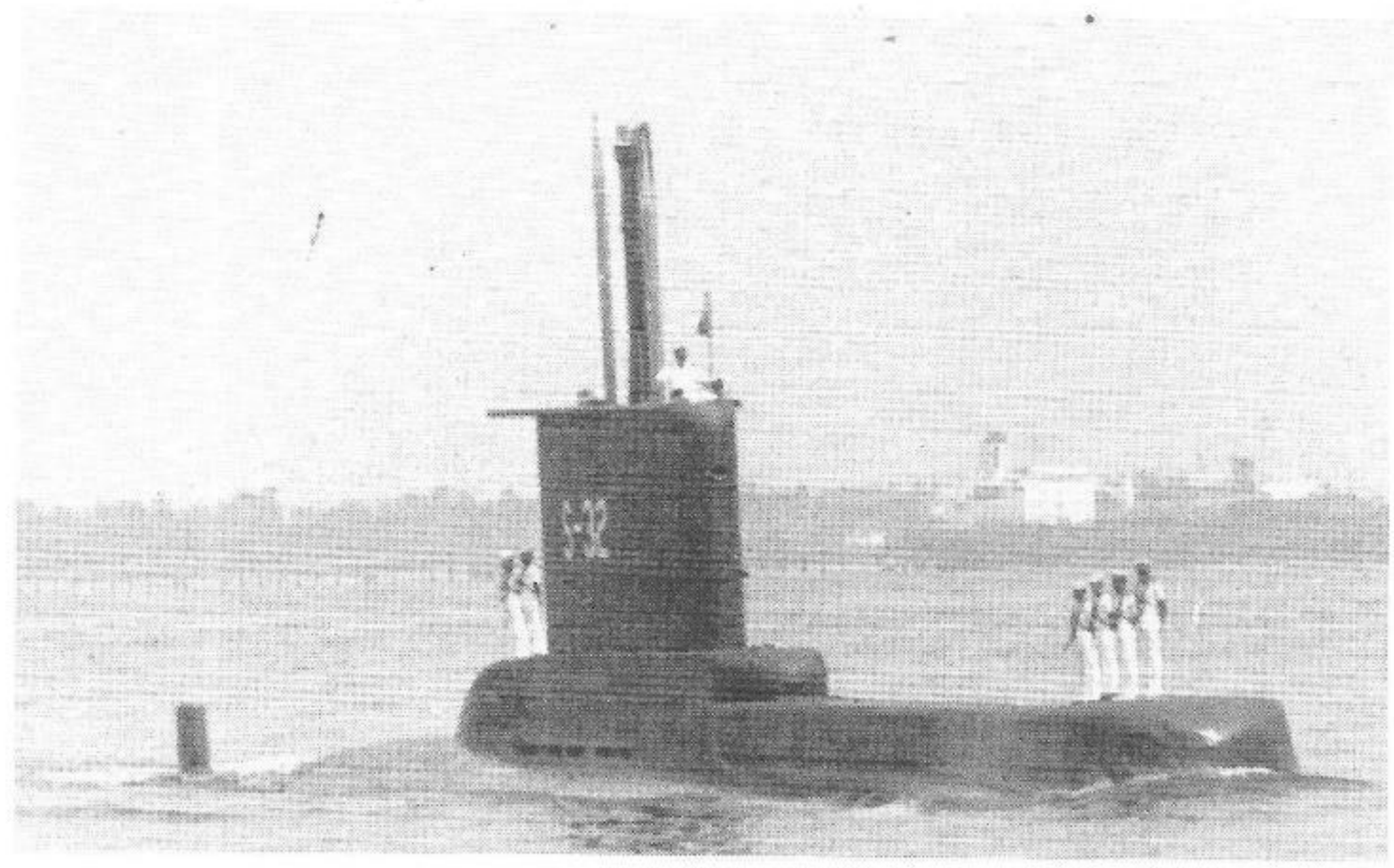
Refits
Sabalo was refitted by HDW at Kiel in 1980/81 (following a fire) and *Caribe* in 1984. Subsequently, *Sabalo* started modernisation in April 1990 at Kiel, but left in late 1992 without fully completing the refit and was followed by *Caribe* which was in refit throughout 1993 and was back in the water in mid-1994, and was completed in 1995.

MODERNISATION

The modernisation work has included slightly lengthening the hull to accommodate a new sonar dome, raising the forward casing and installing new engines, fire control, sonar and attack periscopes.

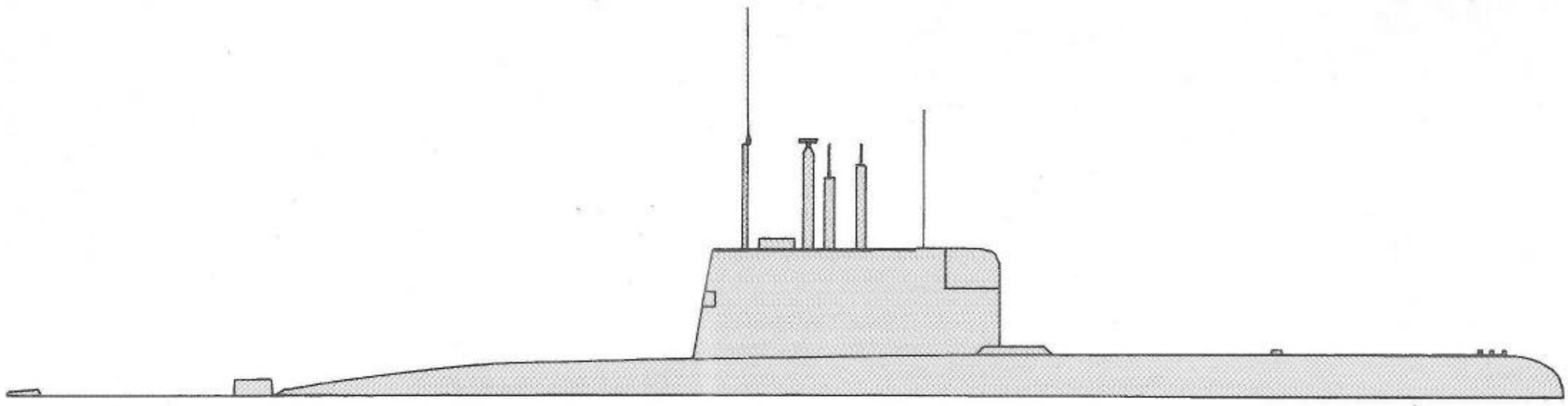
THE FUTURE

The recent modernisation will have fitted the submarines for at least another ten years' working life. The Venezuelan Navy is reported to be considering the purchase of two more of the class. It is also reported that the Venezuelan Navy may acquire British-designed Tigerfish torpedoes from the newly established production facility in Chile.



Caribe *(S 32)* (Venezuelan Navy)

ULA



Ula (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Norway

Class: ULA
Type: Type P 6071 (Type 210)

Built: 6
In service: 6

Displacement:
surfaced: 1,040 t
submerged: 1,150 t

Dimensions
Length: 59 m (193.6 ft)
Beam: 5.4 m (17.7 ft)
Draught: 4.6 m (15.1 ft)

Speed:
surfaced: 11 kts
submerged: 23 kts
Diving depth: 250 m (820 ft)
Range, snorting: 5,000 n miles at 8 kts

Complement: 18-20 (3 officers)

SUBMARINES

ULA (S 300)

Builder	Thyssen Nordseewerke, Emden, Germany
Laid down	29 Jan 1987
Launched	28 Jul 1988
Commissioned	27 Apr 1989

UREDD (S 305)

Builder	Thyssen Nordseewerke, Emden, Germany
Laid down	23 Jun 1988
Launched	22 Sep 1989
Commissioned	3 May 1990

UTVAER (S 303)

Builder	Thyssen Nordseewerke, Emden, Germany
Laid down	8 Dec 1988
Launched	19 Apr 1990
Commissioned	8 Nov 1990

UTHAUG (S 304)

Builder	Thyssen Nordseewerke, Emden, Germany
Laid down	15 Jun 1989
Launched	18 Oct 1990
Commissioned	7 May 1991

UTSTEIN (S 302)

Builder	Thyssen Nordseewerke, Emden, Germany
Laid down	6 Dec 1989
Launched	25 Apr 1991
Commissioned	14 Nov 1991

UTSIRA (S 301)

Builder	Thyssen Nordseewerke, Emden, Germany
Laid down	15 Jun 1990
Launched	21 Nov 1991
Commissioned	30 Apr 1992

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) tubes; bow.
Total weapons carried, 14 torpedoes.

TORPEDOES

STN Atlas DM 2A3 Seeaal

Seeal is a wire-guided, heavyweight, 21 in (533 mm) torpedo for use against surface ships. All essential data are sent to the torpedo throughout its run via a dual-core guidance wire, while actual torpedo running data are simultaneously transmitted back to the ship. An active/passive homing head is fitted with a steerable transducer array. Attack options following acquisition are either by manual or computer control from the launch ship, or by self-homing by the torpedo.

Provision is made for a programmed run after guidance wire payout or loss of signals from the onboard fire-control system. Different programmes adapted to various tactical situations are available and can be selected via the guidance wire. Launch arrangements include compressed air firing from surface ships and swim-out from submarines. There are no limitations on ship movements during the launch and guidance phase. The electric propulsion system employed provides long running distances, permitting launch from beyond target defence area. Torpedo speed is selectable.

Other features are: combined impact and proximity fuze; full performance in shallow or deep water; three-dimensional internal stabilisation; identification of different targets and high-hit probability; automatic system check before firing.

Specifications
Length: 6.08 m (19.95 ft)
Diameter: 533 mm (21 in)
Weight: 1,370 kg (3,020 lb)
Warhead: 260 kg (573.2 lb)
Speed: Selectable, max 35 kts
Range: 15 n mile (28 km) at 23 kts; 7 n mile (13 km) at 35 kts
Guidance: Active/passive
Fuze: Magnetic, proximity or impact

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen/Hamburg, Germany.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Racal Sealion

Sealion is a submarine ESM system designed to provide radar warning and a high-accuracy bearing search capability over the frequency range 0.5 to 18 GHz. It is wide open in bearing and frequency and offers a near 100 per cent probability of intercept. It uses an omnidirectional antenna array and a rotating antenna. The antennas are separate units and may be mounted on separate masts. The omnidirectional antennas provide signals for measurement of amplitude, pulsewidth, frequency and time of arrival of received radar pulses. Processing of this data, together with identification of the radar through the system library, provides the warning function of the ESM system. The rotating dish provides signals for direction-finding for passive targeting and surveillance.

Specifications
Frequency range: 0.5-18 GHz
DF accuracy: 1° RMS

Sensitivity: −60 dBmi
Dynamic range: 55 dB
Library: Up to 3,000 emitter modes

Manufacturer/Contractor
Racal Radar Defence Systems, Chessington, UK.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Kongsberg MSI-90U

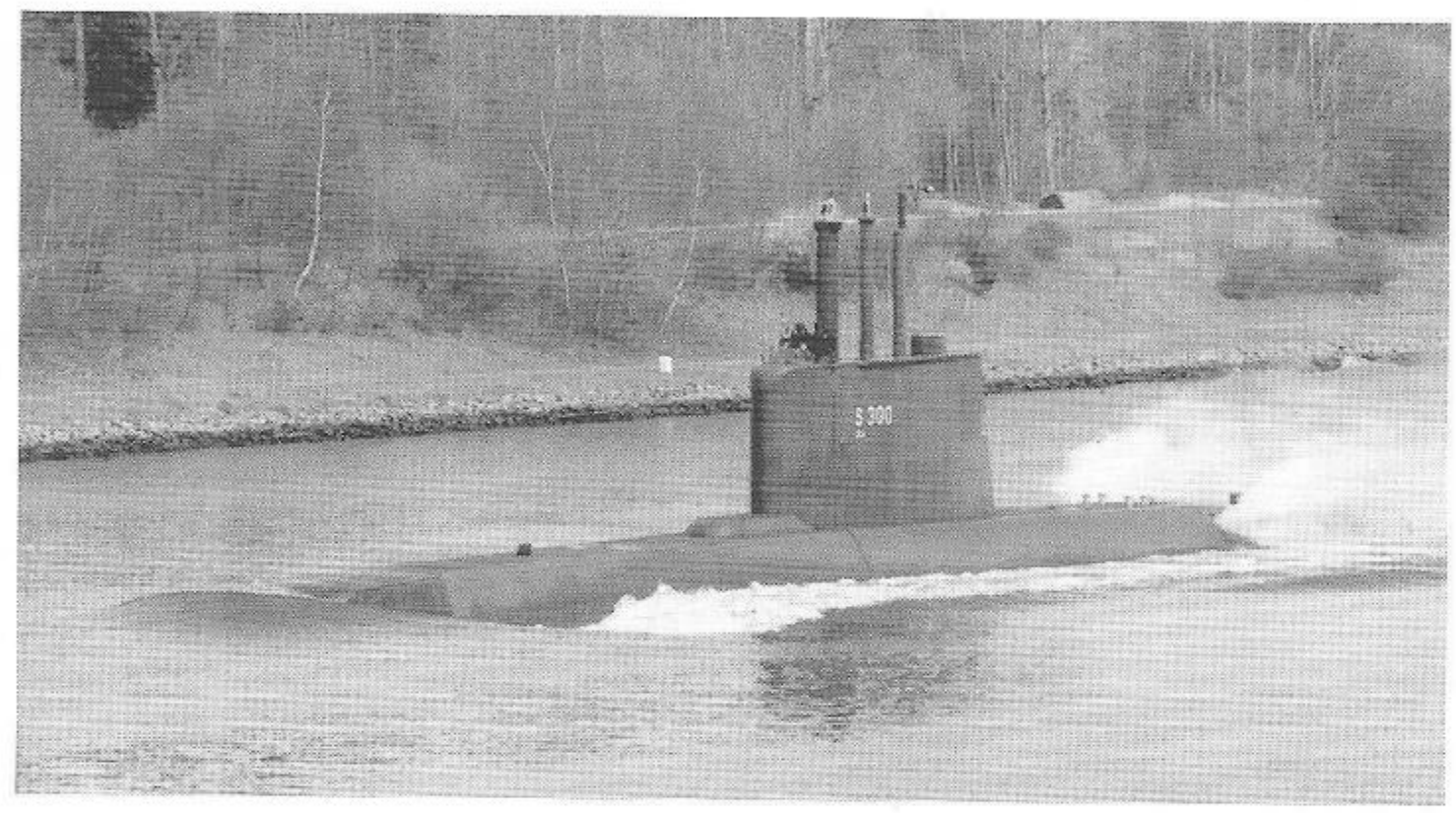
MSI-90U has been designed to meet the requirements of the Royal Norwegian Navy and the German Navy for their next generation of submarines, the Norwegian 'Ula' class and German 'U212' class. It is a software-based command and weapons control system which uses distributed processing, a high-capacity serial data transmission system (LAN), and multifunction operator consoles to achieve a high degree of capability, flexibility and availability.

The LAN, named BUDOS, enables all subsystems to communicate with each other, using standardised interfaces complying with NATO STANAG 4156; standard interfaces such as RS-422 are also available. New subsystems can be connected using either spare interfaces on the existing BUDOS multiplexers, or by adding more multiplexers.

The system is designed to carry out sensor integration covering target-motion analysis, classification and identification, and weapons assignment and control. A number of supplementary facilities is also provided, such as tactical evaluation and navigation, threat evaluation, engagement analysis, preprogrammed movements, sound trajectory calculations and presentations, predicted sonar ranges for 'own ship' and hostile ships, presentation of geographical fixed points and areas, data recording, and simulation.

Manufacturer/Contractor
Kongsberg A/S, Defence Systems Group, Kongsberg.

Utsira *(S 301), the last of the six Ula class to be completed* (H & L van Ginderen Collection)



Ula *(S 300)* (H & L van Ginderen Collection)

RADAR

Kelvin Hughes Type 1007

The radar subsystem is provided by GEC-Marconi, with the Kelvin Hughes Type 1007, mounted on its own mast, providing the major input to the internal workstations and the navigation plot.

Specifications
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 31 dB
Pulsewidth: 0.08/0.35/0.8 µs
Pulse repetition frequency: 1,600/800/400 pps
Scan rate: 26 rpm

Manufacturer/Contractor
Kelvin Hughes, Ilford, Essex, UK.

SONARS

STN Atlas DBQS-21F (CSU-83/1)

The DBQS-21 (CSU-83) sonar suite is designed for submarines of 400 tonnes displacement and upwards, and is the primary sensor of the submarine fire-control and command system of the German Navy. It comprises a passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array covering the frequencies 10 Hz to 2 kHz, a towed array, and two self-noise detectors. The system is claimed to provide high probability of detection over 360°.

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

Thomson Sintra

Thomson Sintra conformal flank arrays are fitted. These are passive devices working at low frequencies.

Utvaer *(S 303) fitting out* (H & L van Ginderen Collection)

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 MTU 16V 396 SB83 diesels; 1.98 MW (2,700 hp(m)) sustained
Electric motor: 1 Siemens motor; 4.41 MW (6,000 hp(m))
Shafts: 1
Battery: Anker

FURTHER INFORMATION

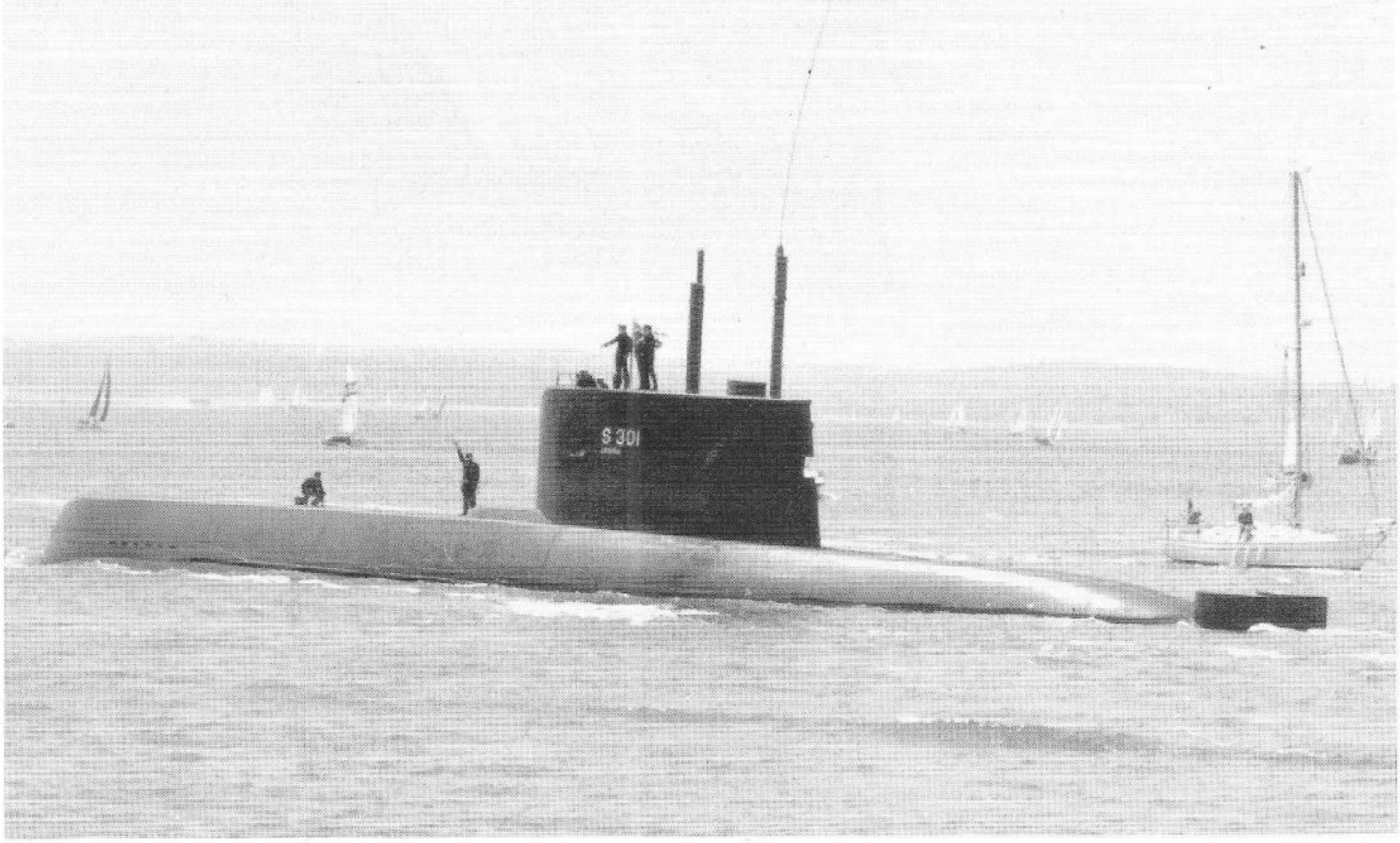
PROGRAMME

The Royal Norwegian Navy (RNorN) enjoyed a particularly successful relationship with the design bureau IKL and the shipbuilders Thyssen Nordseewerke during the Type 207 Kobben programme. It was not, therefore, surprising that the navy should have sought its new submarine, designed to replace half the 'Kobben' class, from the same partners. The result is the most expensive project ever undertaken by the Norwegian Navy, designated the 'Ula' class (known in Germany as the Type 210) with a contract for six signed on 30 September 1982 (the contract included an option on a further two, but this was not taken up).

The project is truly international. The first hull was manufactured in Germany, but the remainder were made by Kvaerner Brug in Norway and then transported to Kiel. The radar (Kelvin Hughes Type 1007) and the EW suite (Racal Sealion) are British, while the sonar is German (STN Atlas DBQS-21F) and the conformal arrays are French (Thomson-Sintra). The periscopes are Italian (Riva-Calzoni) and the navigation system American (Rockwell-Collins), the torpedoes and tubes are German, but the fire-control system is Norwegian (Kongsberg).

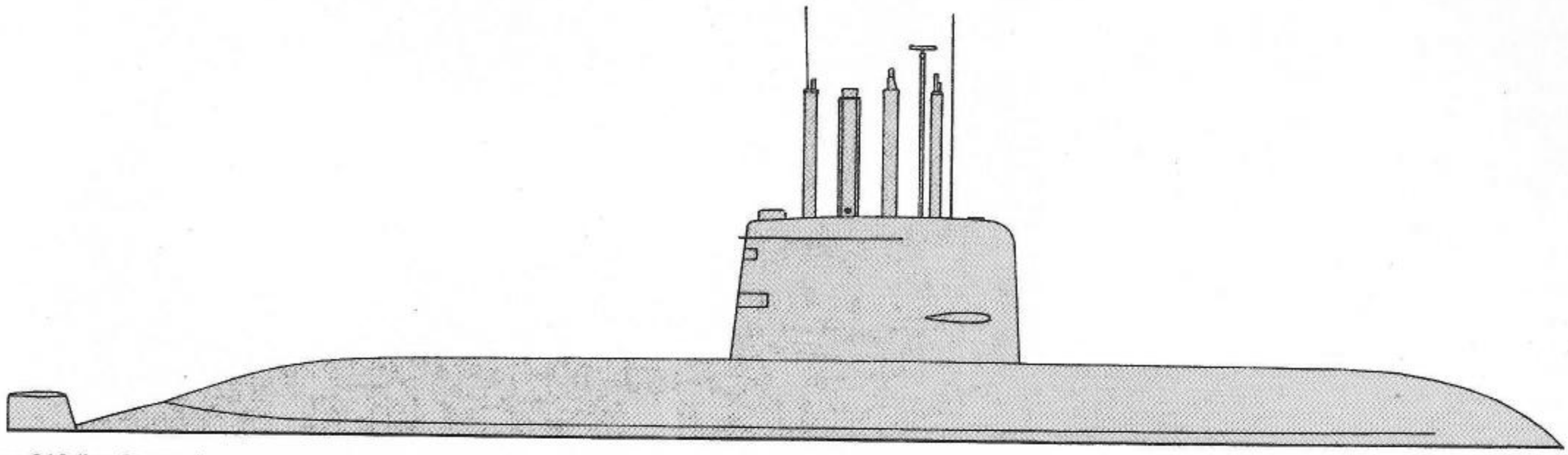
DESIGN

The design is Ingenieurkontor Lübeck (IKL) Type 210 and is unique to the RNorN and is considerably larger than the previous Type 207.



Utsira *(S 301)* (H & L van Ginderen Collection)

U31 (TYPE 212)



Type 212 (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Germany

Class: U 31
Type: 212

In service: 0
Building: 4

Displacement:
surfaced: 1,320 t
submerged: 1,800 t

Dimensions
Length: 53.2 m (174.5 ft)
Beam: 6.8 m (22.3 ft)
Draught: 5.8 m (19 ft)

Speed:
surfaced: 12 kts
submerged: 20 kts
Range:
surfaced: 8,000 n miles at 8 kts
submerged: 420 n miles at 8 kts

Complement: 27 (5 officers)

SUBMARINES

U 31-U 34

WEAPONS SYSTEMS

TUBES

Six 533 mm (21 in); bow tubes; water ram discharge.
Total weapon load, not known.

TORPEDOES

STN Atlas DM2A4
The DM2A4 'Seehake' is being developed specifically for the Type 212, but with due attention to the international market, as well. DM2A4 is a development of the DM2A3 'Seehecht' with a new propulsion system.

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

MINES

Mines can be carried internally in place of torpedoes, or 24 mines can be carried in 'strap-on' containers similar to those on the Type 206A — see 'Further Information'.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT SYSTEMS (ESM)

Telefunken FL 1800U ESM/DF system
FL 1800U is a fully automatic, modular ESM system incorporating USK 800/4 DF system (see next entry), which provides for interception, analysis, DF, classification and display, carrying out automatic analysis and DF on all signals within its coverage of the 2-18 GHz band. Emitters are identified against a stored library and automatic visual and external warnings are given of signals that exhibit certain types of radar characteristics such as lock on. The display features a snapshot mode in which emitter track data can be frozen and reviewed after the ESM sensor has been lowered. Finally the FL 1800U transfers all data to the main combat system.

Manufacturer/Contractor
Telefunken Systemtechnik, Deutsche Aerospace, Ulm (Donau).

Telefunken USK 800
The Type 212 will be fitted with a USK 800 direction-finding system, which also incorporates Global Positioning System (GPS), and VHF/UHF omnidirectional transmit/receive facilities. The antennas are incorporated in the SERO 14 periscope masts and sensor electronics are accommodated in a remote housing. Data are passed to the control room via a single RF coaxial cable (with rotary joint) in the periscope mast. ESM reception is achieved using a biconical antenna with the modelling of the cone contour designed for wide elevation coverage and the greatest possible acquisition range (up to 40 km). To permit the acquisition of vertically, horizontally and circularly polarised EM radiations, the aperture of the antenna is provided with a 45° polariser.

Manufacturer/Contractor
Telefunken Systemtechnik, Deutsche Aerospace, Ulm (Donau), Germany.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Kongsberg MSI-90U
The MSI-90U system is part of the collaborative programme between Norway and Germany, which has led to the 'Ula' class for the Norwegian Navy and the installation of Norwegian equipment in the Type 212. MSI-90U is a software-based command and weapons control system, using distributed processing, a high-capacity serial data transmission system (LAN), and multifunction operator consoles to achieve a high degree of capability, flexibility and availability.

The LAN, named BUDOS, enables all subsystems to communicate with each other, using standardised interfaces complying with NATO STANAG 4156; standard interfaces such as RS-422 are also available. New subsystems can be connected using either spare interfaces on the existing BUDOS multiplexers, or by adding more multiplexers.

The system is designed to carry out sensor integration covering target-motion analysis, classification and identification, and weapons assignment and control. A number of supplementary facilities is also provided, such as tactical evaluation and navigation, threat

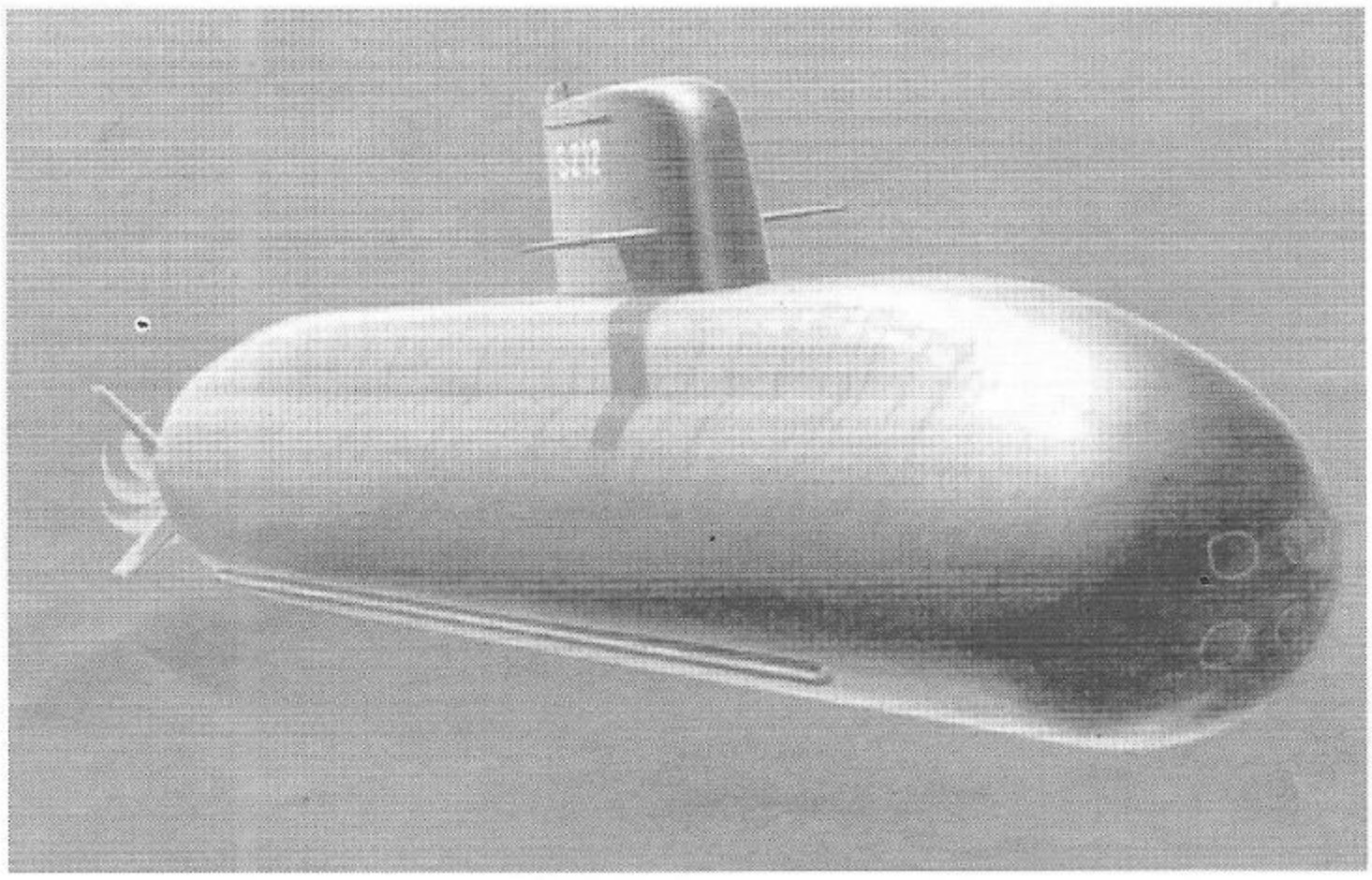
evaluation, engagement analysis, preprogrammed movements, sound trajectory calculations and presentations, predicted sonar ranges for 'own ship' and hostile ships, presentation of geographical fixed points and areas, data recording, and simulation.

Manufacturer/Contractor
Kongsberg A/S, Defence Systems Group, Kongsberg.

RADAR

Specifications
Kelvin Hughes Type 1007
Role: Navigation
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 31 dB
Pulsewidth: 0.08/0.35/0.8 µs
Pulse repetition frequency: 1,600/800/400 pps
Scan rate: 26 rpm

Manufacturer/Contractor
Kelvin Hughes, Ilford, Essex, UK.



Artist's impression of the Type 212 which will serve in both the Italian and German navies (HDW)

SONARS

STN Atlas DBQS-40
The DBQS-40 is an integrated sonar system, consisting of: a cylindrical array for medium-frequency (MF) passive detection; a towed array for low-frequency (LF) detection and classification; flank array to cover the transition between LF and MF coverage; passive ranging base for calculating target course and distance; intercept base to detect hostile sonar emissions; passive ranging and intercept; FAS-3 flank and TAS-3 clip-on passive towed array.

STN Atlas FAS 3-1
FAS 3-1 is the flank array for the Type 212, consisting of two linear 96-stave arrays mounted on either side of the hull. It covers the frequency band from 10 Hz to 2.5 kHz, with a bearing accuracy of 1° for relative bearings of 45 to 135°, which can be extended, albeit with reduced accuracy to 10 to 170°. The actual length of the Type 212 installation is not known, but in general FAS 3-1 arrays can be 20 to 48 m long, each with 64/96 staves, for a total of 196/288 hydrophones.

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

Ferranti-Thomson FMS 52
The FMS-52 (FMS = Ferranti Modular Sonar) is a high-frequency, active navigation and obstacle avoidance sonar, designed to minimise the chance of hitting submerged objects, including mines. The equipment uses beam-steering with a bearing resolution of 3°. There are four hull-mounted arrays to give 360° coverage.

Manufacturer/Contractor
Ferranti-Thomson Sonar Systems, Stockport, UK.

STN Atlas DBQS-21 (CSU 83) passive/active sonar system
The DBQS-21 sonar is the primary sensor of the submarine fire-control and command system and consists of a cylindrical passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array, a sonar intercept array and two 'self-noise' detectors. (Note: the export designation for this system is CSU 83, where CSU = Compact Sonar for U-boats.)

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen, Germany.

PERISCOPES

Search
Carl Zeiss SERO 14, with optical rangefinder, thermal image sensor and combined ESM/GPS facilities.

Attack
SERO 15 mod, with optical and laser rangefinder.

Manufacturer/Contractor
Carl Zeiss, D-73446 Oberkochen, Germany.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 3 MTU 16V 396 diesel; 3.12 MW (4,243 hp(m))
Alternators: 3
Electric motor: 1 Siemens Permasyn motor; 2.85 MW (3,875 hp(m))
Shafts: 1 shaft
Propeller: 7-bladed, skew-back
AIP system: HDW fuel cell system
Battery: Sodium sulphide high-energy batteries

FURTHER INFORMATION

PROGRAMME

The most recent new-build submarine to be commissioned into the German Navy was U 30, which joined the fleet on 13 March 1975, but, as with all contemporary submarine programmes, there was a very lengthy discussion process before the initial order for this new type of submarine was announced. The design phase was completed in 1992 by ARGE 212 (HDW/TNSW) in conjunction with IKL, but authorisation for the first four of the class was not given until July 1994 and the first steel is unlikely to be cut until 1997. The work will be shared between HDW (Howaldtswekrke) Kiel, and TNSW (Thyssen Nordseewerke) Emden, and the first of class is scheduled to enter service in 2003.

DESIGN

The pressure hull is constructed of austenitic steel, which combines high strength and elasticity, and is also non-magnetic. The hull has been designed with a safety factor of two between the maximum operating depth and calculated collapse.

The submarine has a hybrid hull design, with a large diameter, single hull forward and a smaller diameter, double hull aft, the two being connected by a short, conical section. The larger diameter section contains a double-deck section, with the Combined Control and Operations Centre on the upper deck and equipment below, with accommodation forward and the torpedoes in the forward bulkhead.

The fuel cell plant is housed in the conical section, with the main machinery in the smaller diameter section aft. The LOX (liquid oxygen) and hydrogen storage tanks are grouped around the after hull, inside the free-flooding outer casing. This after part of the submarine is intended to be unmanned during operations.

In order to achieve greater manoeuvrability, the Type 212 makes two innovations in German submarine design. First, the forward hydroplanes have been moved from the lower bows to the sail and, second, the after control surfaces are an 'X' configuration. Propulsion is by means of a conventional seven-bladed, skew-back propeller.

It should be noted that after some 50 years of using 'swim-out' technique for torpedo launching in all German submarines produced for both their own and foreign navies, the Type 212 uses a hydraulic water-ram system. This is claimed to give low-noise discharge, even of heavyweight torpedoes, an absence of swell or bubbles, high-discharge velocity, and no restrictions on submarine operation up to 12 knots.

AIP SYSTEM

The Type 212 will be fitted with a hybrid fuel cell/battery propulsion system based on the HDW prototype, which was successfully evaluated in U1 in 1988-89. That prototype had 16 fuel cells each generating 25 kW of power, but the production system will have a more powerful system using solid polymer technology rather than liquid electrolyte.

ARMAMENT

The Type 212 will not normally carry any reload torpedoes, although provision has been made for a number to be carried in operations, although this will be at

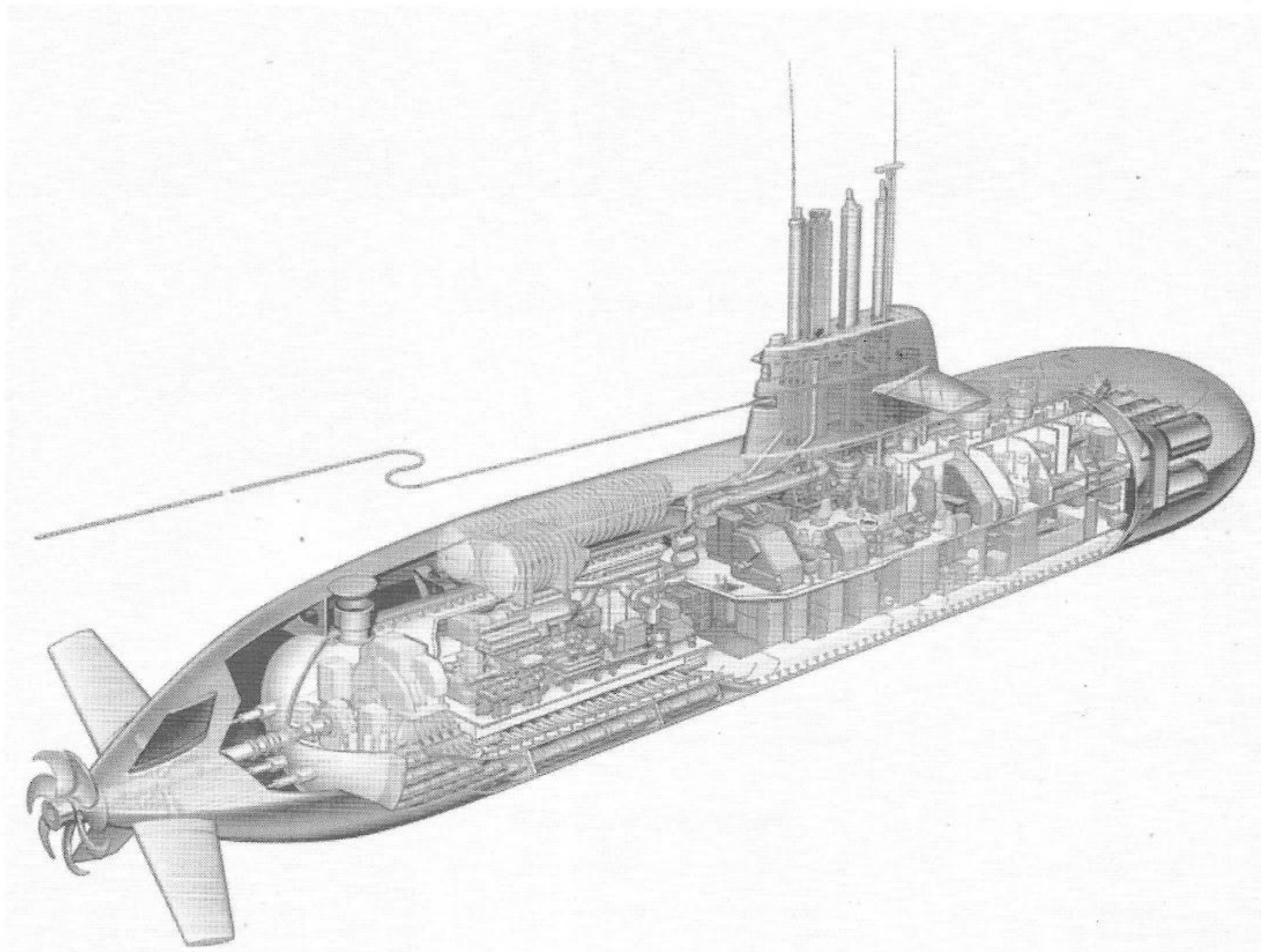
the expense of a certain degree of comfort in the living accommodation.

If mines are to be carried internally this can only be done on a basis of three ground-lying mines or two anchored mines per tube. Such a system will leave the submarine relatively defenceless, due to a lack of torpedoes. In addition to this, swim-out tubes are less suitable than other types for minelaying, since a compressed air ejection system must be added.

To overome these problems, IKL has developed a strap-on minelaying 'girdle' consisting of two separate boxes, each conbtaining 12 vertical mine tubes. The mines are loaded from above and are held in place by a hydraulically operated latch, controlled from inside the submarine. The boxes are free-flooding and on release of the latch the mine descends under gravity. Whether full or empty, the boxes can be jettisoned in an emergency.

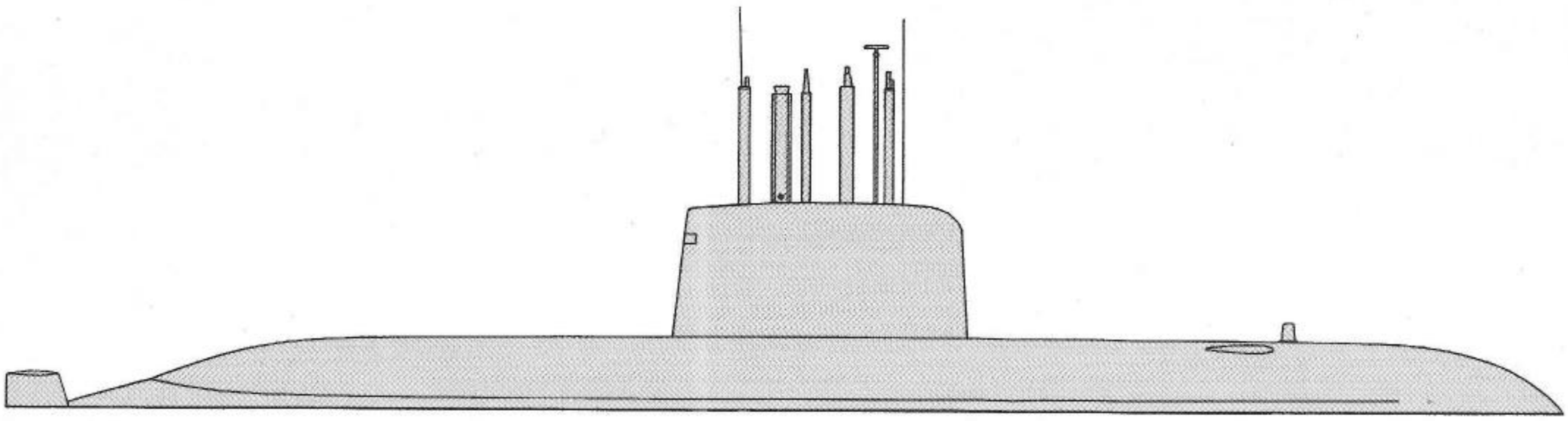
EXPORT

Italy intends to produce two Type 212s at the Fincantieri yard at Monfalcone. These will incorporate certain modifications to meet Italian requirements, possibly including air-independent propulsion (AIP). Under this plan the first hull would be laid down in 1998, followed by the second five years later.



Cutaway of the Type 212. The after part of the pressure hull contains the engines and motors and is normally unmanned. The short conical section contains the fuel cells, while the forward section contains the double-decked operations and accommodation facilities (HDW)

DOLPHIN (TYPE 212)



Dolphin (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Israel

Class: DOLPHIN
Type: 212

Building: 3
Active: 0

Displacement:
surfaced: 1,640 t
submerged: 1,800 t

Dimensions
Length: 57.3 m (188 ft)
Beam: 6.8 m (22.3 ft)
Draught: 6.2 m (20.3 ft)

Speed:
snorting: 11 kts
submerged: 20 kts
Diving depth: 350 m (1,150 ft)

Range:
surfaced: 8,000 n miles at 8 kts
submerged: 420 n miles at 8 kts
Endurance: 30 days.

Complement: 30 (6 officers)

SUBMARINES

Laid down	15 Feb 1992	**Laid down**	Aug 1992	**Laid down**	Jul 1994
Launched	15 Apr 1996	**Launched**	Oct 1996	**Launched**	Oct 1997
Commissioned	1997	**Commissioned**	1998	**Commissioned**	1999

WEAPONS SYSTEMS

ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Sub-Harpoon Block 1C

Block 1C has a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

Six 533 mm (21 in); bow.
Total weapon load, 14 torpedoes/missiles.

TORPEDOES

Alliant Mk 48 Mod 4

The Mk 48 torpedo is an anti-submarine and anti-ship weapon, capable of operating in wire-guided, acoustic and non-acoustic modes, with the acoustic modes being either active or passive. Externally the Mk 48 is a long slim cylinder with a flat nose and four fin-like wire dispensers faired into the after body ahead of the shrouded, axial flow, pump-jet propulsor. The wire link is two-way, enabling data from the weapon's homing and guidance system to be relayed to the submarine fire-control system, so that the weapon can be guided more accurately from the submarine.

Specifications
Length: 5.84 m (19.16 ft)
Diameter: 533 mm (21 in)
Weight: 633 kg (1,395 lb)
Range: 21 n miles (38 km) at 55 kts or 27 n miles (50 km) at 40 kts
Max depth: 760 m (2,490 ft)
Max speed: 55 kts
Warhead: 267 kg (589 lb)

Manufacturers/Contractors
Hughes Aircraft Company, Ground Systems Group (prime).
Westinghouse Electric Corporation (second source).

MINES

Mines can be carried internally in lieu of torpedoes. As far as is known the Israeli Navy does not intend to purchase the 'strap-on' mine belts being procured for the German Type 212.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Elbit Timnex 4CH(V)2

The ESM system is the Israeli-designed Elbit Timnex 4CH(V)2, which is already in service with the Australian and Israeli navies. This system's primary role is omnidirectional intelligence gathering (ELINT) with threat warning as a secondary activity. It covers the 0.4 to 40 GHz band

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

STN Atlas ISUS, integrated combat system

ISUS is an integrated submarine combat system designed to acquire, process, analyse and display data from all sensors fitted in the boat, and, in particular for the CSU-83 sonar suite. The system integrates a wide variety of acoustic arrays including: cylindrical or conformal; flank; towed; passive ranging; cylindrical transducer; and intercept, as well as own noise hydrophones and accelerometers; Doppler and EM log; underwater telephone; radar; ESM; optic and optronic sensors and navigation sensors. Among the functions performed by the system are: broadband detection over 360°; broadband sonar pulse detection over 360°; detection of low-frequency spectral lines over a long range; transient detection and storage; range measurement in two 120° sectors; navigation, and detection of own hydrodynamic and machinery noise. It also carries out automatic and interactive tracking of targets; audio broadband and narrowband analysis leading to computer-aided classification suggestion; threat analysis; launching suggestion for weapons; integration of the torpedo sonar information from wire-guided torpedoes; launching of Sub-Harpoon; control of wire-guided torpedoes and display of the target/weapon situation.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen, Germany.

RADARS

The type of surface search radar to be installed has not been announced although it seems possible that it might use the Israeli-designed Elta EA-20/SRD antenna

SONARS

STN Atlas CSU 90

Israel has selected the CSU 90 (CSU = Compact Sonar for U-boats), which comprises three main sonars: an attack panoramic passive sonar, consisting of a 2.8 m cylindrical hydrophone array, with full azimuth coverage; FAS 3 low-frequency flank array sonar, used for long-range detection; and PRS 3 passive ranging sonar, which consists of six arrays, three on each side. These 15-stave arrays have a high-directivity index.

Any target detected by one of these sonars initiates an automatic process of data collection. CSU 90 is equipped with eight independent compound tracks, each providing the warfare system with a complete set of tactical data. Tracks are automatically incorporated in a compound track and each sensor can initiate a compound track. The total set of compound tracks comprises:

(a) eight ATT channels for the attack sonar
(b) eight ATT channels for the Demon path, each with eight ALTs
(c) the Target Motion Analyser (TMA) which controls eight compound tracks and generates a sonar tactical display
(d) TMA controls providing further manual tracks
(e) flank array sonar with eight ATT channels and eight MTs with eight ALTs each.

Extensions include a passive ranging sonar, a 'self-noise' analyser, acoustic passive classification, automatic warning channel, target motion analyser, a disk memory unit, plotting devices and simulation facilities. The disk memory unit allows all displays and sonar data to be recorded for subsequent analysis and for training. It also handles the data for comparison purposes of the sonar information processor and the classification file for the intercept sonar.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen.

PERISCOPES

Two Kollmorgen periscopes.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 3 MTU 16V 396 SE 84 diesels; 3.12 MW (4,243 hp(m) sustained
Alternators: 3 alternators; 2.91 MW
Electric motor: 1 Siemens motor; 2.85 MW (3,875 hp (m)) sustained
Shaft: 1 shaft
Propeller: 7-bladed, skew-back

FURTHER INFORMATION

PROGRAMME

The Israeli Navy has long been seeking additional submarines and in mid-1988 the Ingalls Shipbuilding Division of Litton Corporation in the USA was selected to be the prime contractor for two IKL-designed 'Dolphin' class submarines. These would have been built in Germany by HDW in conjunction with Thyssen Nordseewerke, using US funds provided under the FMS (Federal Military Sales) programme. That funding was approved in July 1989 with an effective contract date of January 1990 but the project was then cancelled in November 1990 due to pressures on US defence funds.

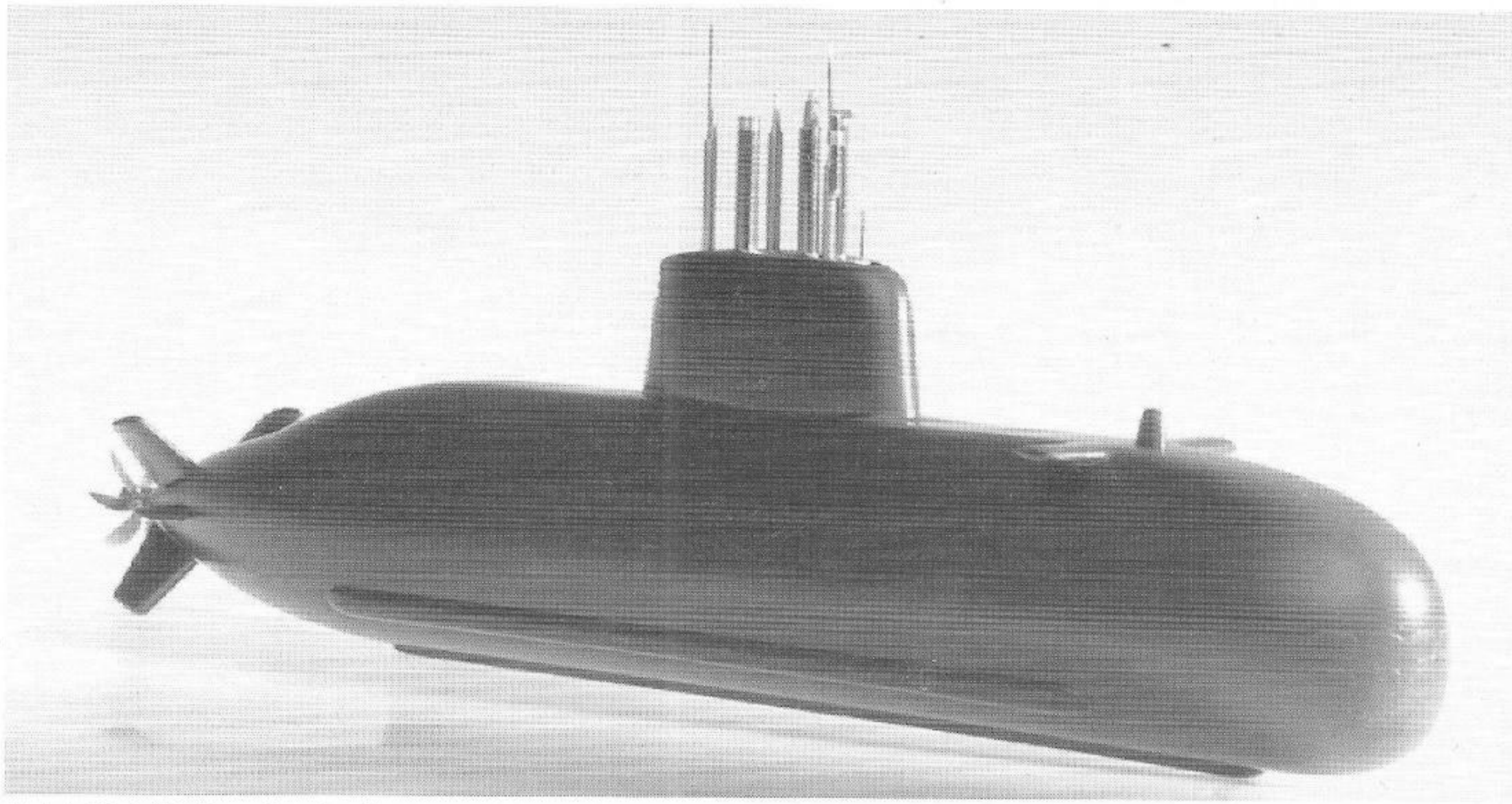
The contract was resurrected following the April 1991 Gulf War, but this time with German funding for two submarines with an option on a third. The first steel was cut on 15 February 1992 by HDW at Kiel and the first sections were moved to Emden for completion by TNSW in October 1994. The first hull was launched 15 April 1996 with sea trials planned for the end of 1996. The second hull is following the first by six months and the option on the third of class was taken up in July 1994. Project completion is due in late 1999.

DESIGN

The 'Dolphin' class is generally similar to the German Type 212 in design but with the addition of a 'wet and dry' compartment for underwater swimmers.

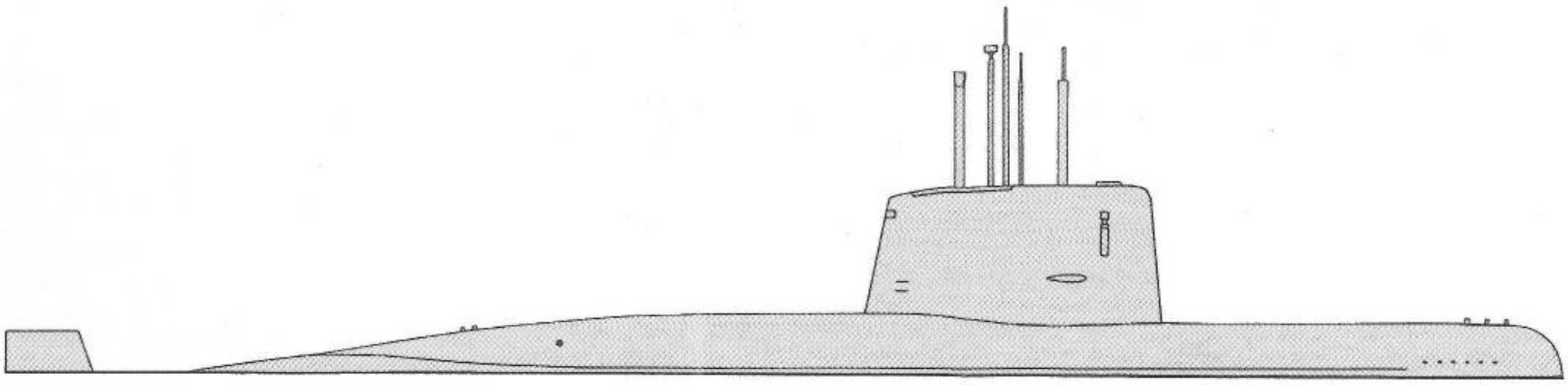
OPERATIONAL

These boats will be used for interdiction, surveillance and special boat operations.



Model of 'Dolphin' class submarine. Note the position of the forward hydroplanes, which is different from that on any other recent German design (HDW)

SANTA CRUZ (TR 1700)



Santa Cruz (TR1700) (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Argentina

Class: SANTA CRUZ
Type: TR 1700

Built: 2
In service: 2
Building: 2 (see Further Information)

Displacement:
surfaced: 2,116 t
submerged: 2,264 t

Dimensions
Length: 66.0 m (216.5 ft)
Beam: 7.3 m (23.9 ft)
Draught: 6.5 m (21.3 ft)

Speed:
surfaced: 15 kts
snorting: 15 kts
submerged: 25 kts
Range:
surfaced: 12,000 n miles at 8 kts
submerged: 20 n miles at 25 kts, 460 n miles at 6 kts

Diving depth: 300 m (984 ft)
Endurance: 70 days

Complement: 26 plus 6 spare berths

SUBMARINES

SANTA CRUZ (S-41)
Builder Thyssen Nordseewerke, Emden, Germany
Laid down 6 Dec 1980
Launched 28 Sep 1982
Commissioned 18 Oct 1984

SAN JUAN (S 42)
Builder Thyssen Nordseewerke , Emden, Germany
Laid down 18 Mar 1982
Launched 20 Jun 1983
Commissioned 19 Nov 1985

SANTA FE (S 43)
Builder Astilleros Domecq Garcia, Buenos Aires, Argentina
Laid down 4 Oct 1983
Current status See 'Further Information'

SANTIAGO DEL ESTERO (S 44)
Builder Astilleros Domecq Garcia, Buenos Aires, Argentina
Laid down 5 Aug 1985
Current status See 'Further Information'

WEAPONS SYSTEMS

TUBES

Six 533 mm (21 in) bow tubes.
Total weapon load, 22.

TORPEDOES

STN Atlas SST 4 Mod 1

SST 4 (Special Service Target #4) is a wire-guided, heavyweight, 533 mm (21 in) torpedo for use against surface ships and is essentially an export version of the German Navy's DM2 Seeaal. The 260 kg warhead is in the centre of the weapon with an impact fuze and behind it are the silver-zinc batteries, which are identical to those of the DM2 Seeaal. The torpedo operates at depths between 4.5 m and 460 m (15 ft and 1,500 ft) with the weapon guided from the launcher submarine until the wire is fully dispensed. The torpedo then conducts a passive search before using active homing for the terminal phase or to reacquire the target.

The design has been improved over the years, especially in the homing head functions and in the stabilisation and related control system and the Argentine Navy is one of those to have acquired the SST Mod 1 upgrading kit, which includes further improvements covering additional return signals (actual course, speed and depth) and a magnetic proximity fuze.

Specifications
Length: 6.08 m (19.95 ft)
Diameter: 533 mm (21 in)
Weight: 1,363 kg (3,005 lb)
Warhead: 260 kg (573 lb)
Propulsion: Electric
Speed: 23-35 kts
Range: 6.6 n miles (12 km) at 35 kts; 15.3 n miles (28 km) at 23 kts
Operating depth: 4.5-460 m (15-1,500 ft)

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

MINES

The tubes can be used for mines, but there is no evidence that Argentina has bought any.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Kollmorgen Sea Sentry Version III

Sea Sentry Version III (also known as Model 962U) is an ESM system providing automatic detection and direction-finding, together with an ELINT library. Up to 35 emitters can be processed, with 15 displayed.

Specifications
Frequency band: 100 kHz – 18 GHz
Accuracy: >10°
Coverage: 360°

Manufacturer/Contractor
Kollmorgen Electro Optical, Northampton, Massachussets, USA.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Signaal SINBADS (Submarine INtegrated Battle And Data System)

SINBADS was developed from Signaal's M8 and is an integrated command and weapon control system using a federated architecture and consisting of a central processing cabinet, Display and Control Consoles (DaCC), and two weapon electronics cabinets. The weapon electronics cabinets are installed near the torpedo tubes controlling half the weapon launching system and are used to warm up the weapons, preset torpedoes, and provide firing signals to the weapons and launching systems. They perform weapon control and ballistic calculations and guide torpedoes after launch. During surveillance operations one will be switched off to conserve power. The tracking algorithm is based upon Kalman filtering while the tracking system is based upon bearing-only analysis, although it can accept other target data inputs. The system can track five targets while simultaneously operating three torpedoes. It may also be used with Harpoon missiles.

Manufacturer/Contractor

Hollandse Signaalapparaten BV, Hengelo, Netherlands.

RADAR

Thomson-CSF DRUA-33 (Calypso IV)

DRUA-33 radar (also known as Calypso IV) carries out airspace and surface surveillance while the submarine is on the surface, and is also used for navigation. There is a single operating console below and the rotating antenna is positioned atop a mast to give maximum coverage. An earlier version was quoted as being able to detect a 10 m^2 target, such as an ASW aircraft, at 18 n miles and a height of 2,500 m (8,200 ft).

Specifications

Role: Surveillance and navigation
Frequency bands: I/J
Pulse: 1 ms
Peak output power: 25 kW
Range: 17 n miles (31 km) for 10 m^2 target

Manufacturer/Contractor

Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

SONARS

STN Atlas CSU 3-4

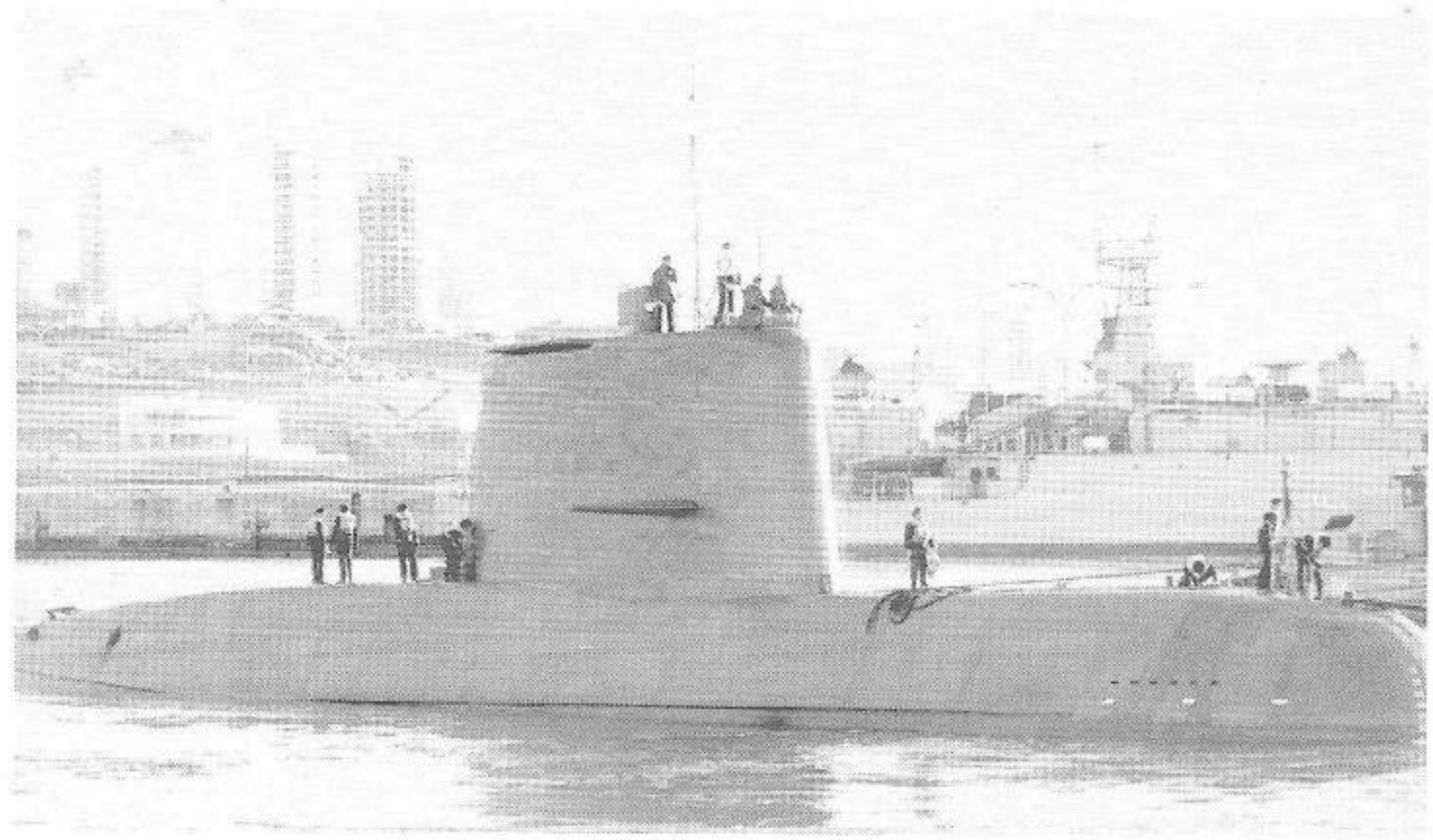
CSU 3-4 is a fast-scanning medium-range, medium-frequency, active/passive sonar, which can be used as a long-range passive device, an intercept sonar and as an underwater telephone. The equipment has an AN 5039 cylindrical array and uses electronic scanning thus generating less self-noise than the CSU 3-2, which uses an active antenna that is tilted and rotated mechanically.

Manufacturer/Contractor

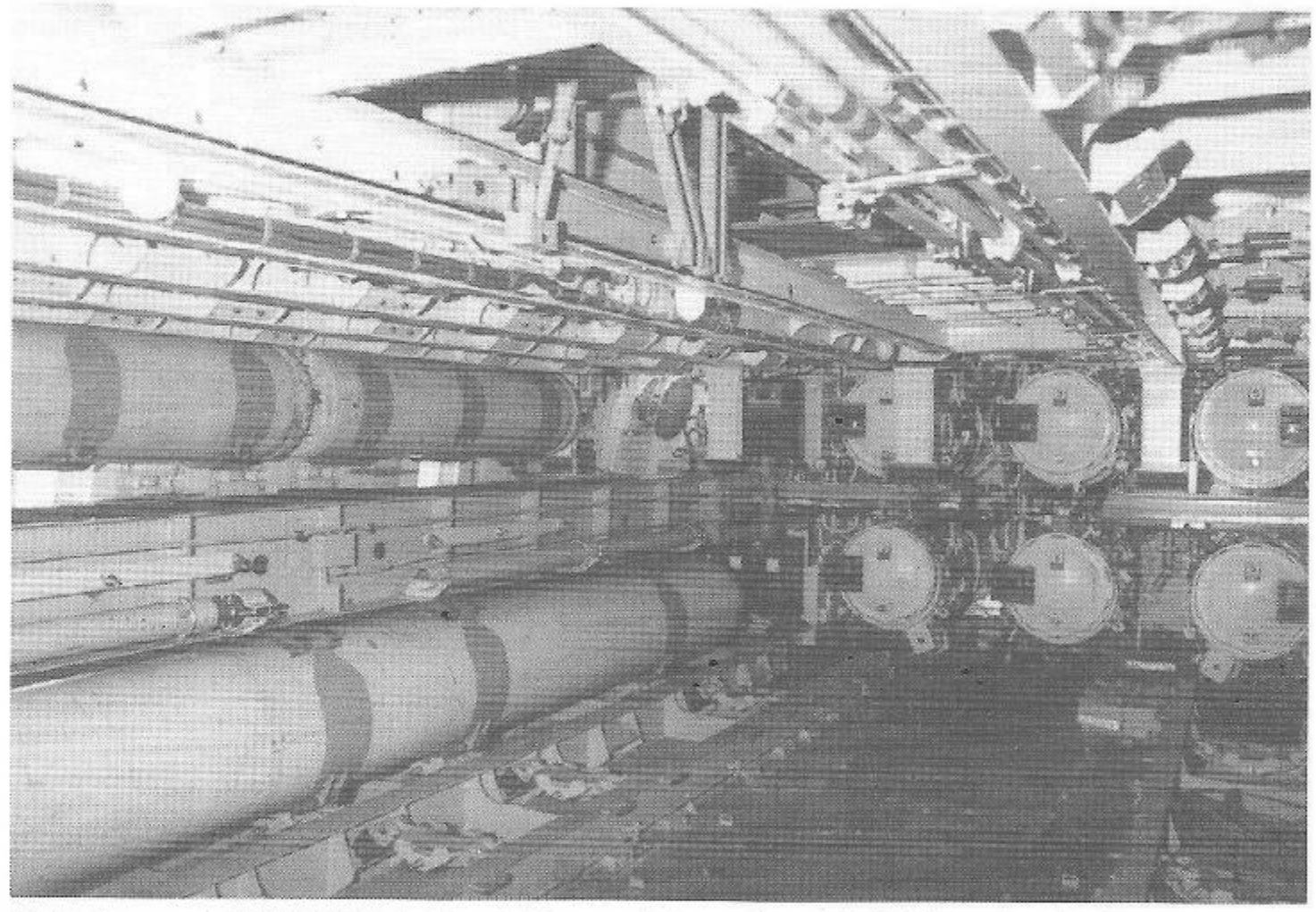
STN Atlas Elektronik GmbH, Bremen, Germany.

Thomson-Sintra DUUX-5 Fenelon

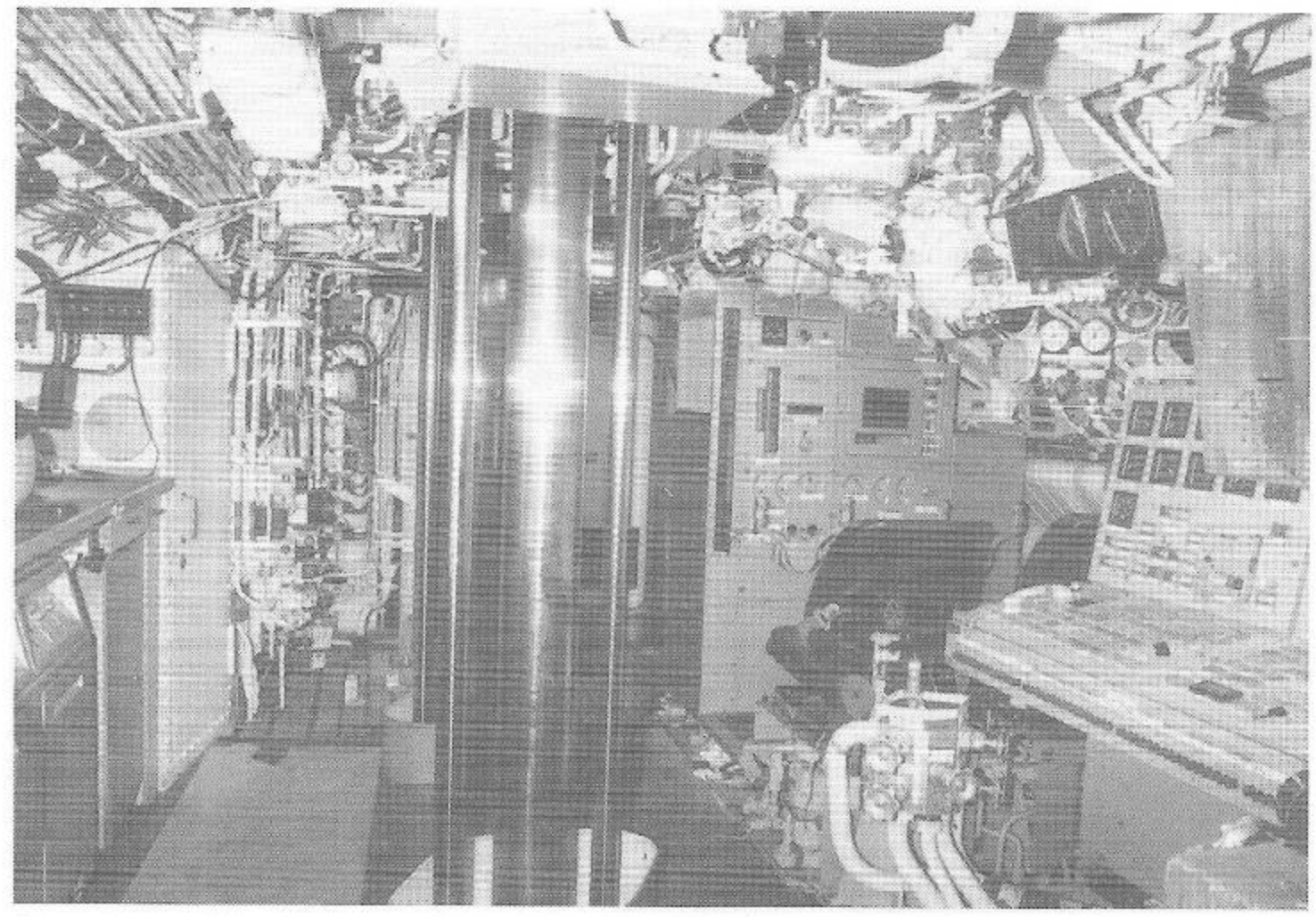
DUUX-5 panoramic sonar is fitted, which can track four targets simultaneously. It incorporates a passive acoustic rangefinder for measuring the range of three targets within 120° sectors, and a panoramic sonar interceptor measuring the true bearing of all sonar transmissions received in the 2-15 kHz band. Four targets can be tracked simultaneously (three on radiated self-noise, one on sonar pulses), and there is a continuous panoramic bearing display over 360°. Target data is automatically transmitted to the ship's weapon control system and plotting table. Under normal conditions, results in the middle sector are 0.3° for bearing accuracy, 2° discrimination accuracy between two targets and 5 per cent of range on radiated noise for a target at 10 km distance. The hydrophonic unit is composed of two bases with three hydrophones each on the starboard and port sides of the submarine. All other technical details remain classified.



Santa Cruz *(S 42) in Argentina* (Argentine Navy)



Torpedo room in TR 1700. Note the six tubes and dummy torpedo (left, lower) and mines (left, upper) (TNSW)



Control room of San Juan *(S 42) with steering position at front right* (TNSW)

Manufacturer/Contractor

Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, France.

PROPULSION

Specification
System: Diesel-electric
Main Machinery: 4 MTU 16V 652 MB81 diesel generator sets; each 970 kW

Propulsion motor: 1 Siemens four-circuit DC motor; 6.6 MW
Shafts: 1
Battery: 8 groups of 120 cells; 5,858 A/10 h

FURTHER INFORMATION

PROGRAMME

It is somewhat surprising that these are the only examples of this large and capable design to have been built, which are the largest submarines to be built in Germany since the end of the Second World War and are also the fastest diesel-electric submarines currently in service anywhere in the world with a 'burst' speed of 26 knots.

Argentina signed the contract with Thyssen Nordseewerke on 30 November 1977 for six submarines: two TR 1400s and four of the larger TR 1700. The order for the two TR 1400s was, however, later changed to two more TR 1700s, with the first two being built at Emden, Germany while the remaining four would be built in Argentina by Astilleros Domecq Garcia in Buenos Aires. Thyssen built and delivered the first two boats on schedule.

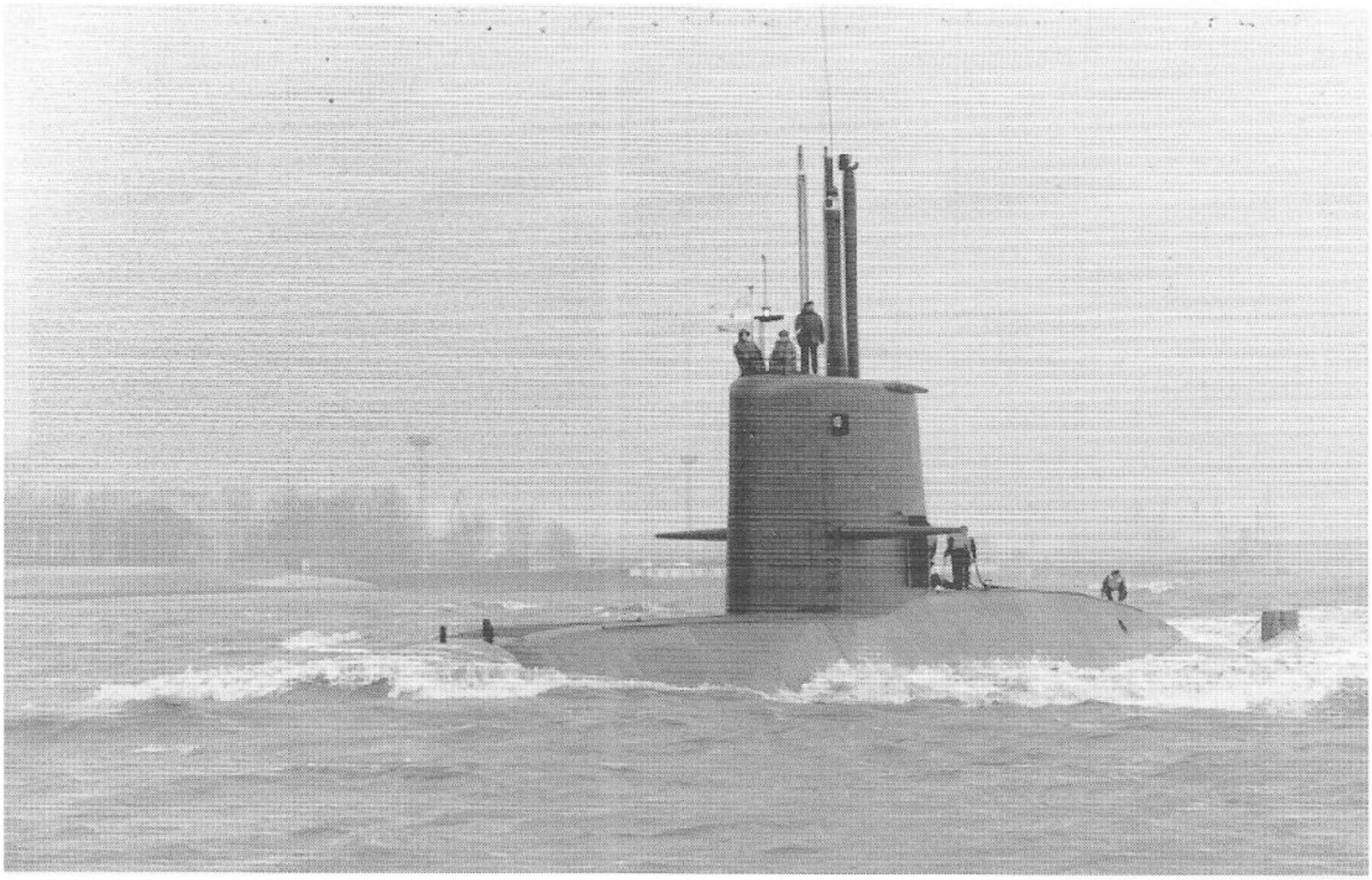
Construction in Argentina was nothing like so smooth and in early 1996 *Santa Fe* (S 43) was 52 percent complete and *Santiago del Estero* (S 44) just 30 per cent complete, and no work had been done on either for at least twelve months. Both have long been offered for sale and one possibility would be to send these two partly completed hulls to Thyssen Nordseewerke for completion, which would both rid the Argentine Navy of a financial embarrassment and also clear the yard for privatisation. Any hope of even starting hulls number five and six has long been abandoned and the equipment already assembled is being used for spares.

MODERNISATION

There have been reports that the Argentine Navy is conducting negotiations with Thysssen Nordseewerke with a view to installing a closed-cycle, air-independent propulsion system in at least one of its two operational submarines. In addition, if the two partially completed hulls are purchased by a shipyard for resale to a third party, a complete refit, including, perhaps, an AIP system would be necessary.

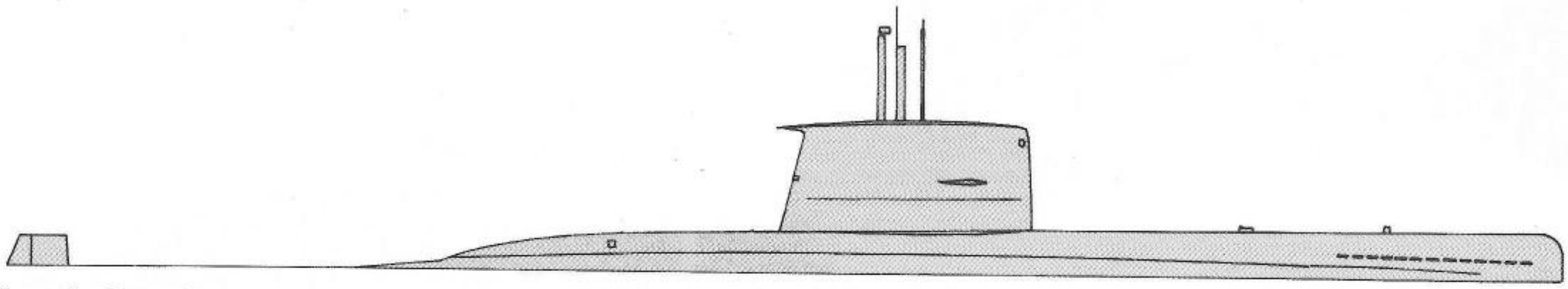
OPERATIONAL

The first two of the class are operational and are the largest and most capable submarines in the Argentine Navy.



Argentina's first TR 1700, Santa Cruz *(S 42), leaves Emden on the delivery voyage to Argentina in December 1984* (TNSW)

SAURO



Sauro (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Italy

Class: SAURO
Type: 1081

Built: 4
In service: 4

Displacement:
surfaced: 1,456 t
submerged: 1,631 t

Dimensions
Length: 63.9 (210 ft)
Beam: 6.8 m (22.5 ft)
Draught: 5.7 m (18.9 ft)

Speed:
surfaced: 11 kts
snorting: 12 kts
submerged: 19.3 kts
Range:
surfaced: 11,000 n miles at 11 kts
submerged: 300 n miles at 4 kts

Diving depth:
normal: 250 m (820 ft)
max: 300 m (985 ft)
Endurance: 35 days

Complement: 49 (6 officers) plus 4 trainees

SUBMARINES

Nazario Sauro (S 518)
Builder Italcantieri, Monfalcone, Italy
Laid down 27 Jun 1974
Launched 9 Oct 1976
Commissioned 12 Feb 1980

Fecia di Cossato (S 519)
Builder Italcantieri, Monfalcone, Italy
Laid down 15 Nov 1975
Launched 16 Nov 1977
Commissioned 5 Nov 1979

Leonardo da Vinci (S 520)
Builder Italcantieri, Monfalcone, Italy
Laid down 8 Jun 1978
Launched 20 Oct 1979
Commissioned 23 Oct 1981

Guglielmo Marconi (S 521)
Builder Italcantieri, Monfalcone, Italy
Laid down 23 Oct 1979
Launched 20 Sep 1980
Commissioned 11 Sep 1982

WEAPONS SYSTEMS

TUBES

Six 533 mm (21 in) bow tubes; swim-out discharge. Total weapon load, 12.

TORPEDOES

Whitehead A 184
The Whitehead A 184 is a dual-purpose (surface vessels and submarines) wire-guided torpedo with a 250 kg HBX warhead with magnetic influence and impact fuzes. The weapon is capable of two speeds, 24 and 36 knots and is launched by swimming-out. Commands carried by the guidance wires include: course, depth, acoustic mode (active, passive and combined), enabling range, stratum allowed, speed, impact and influence fuze setting, torpedo stop. Replies from the weapon include: course, distance, depth, acoustic mode, speed, other data on interrogation. The A 184 is used in all Italian submarines, but the only export order has been from Peru.

Specifications
Length: 6 m (19.69 ft)
Diameter: 533 mm (21 in)
Weight: 1,265 kg (2,789 lb)
Warhead: 250 kg (551 lb) HBX HE
Propulsion: Electric
Homing: Active/passive
Performance: 13.7 n miles (25 km) at 24 kts; 9.2 n miles (17 km) at 38 kts
Speed: 24 or 36 kts

Manufacturer/Contractor
Whitehead SpA, Salviano, Italy.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Elettronica BLD 727
Elettronica BLD-727 radar warning set. There are two antennas; one on a mast, the other in the search periscope.

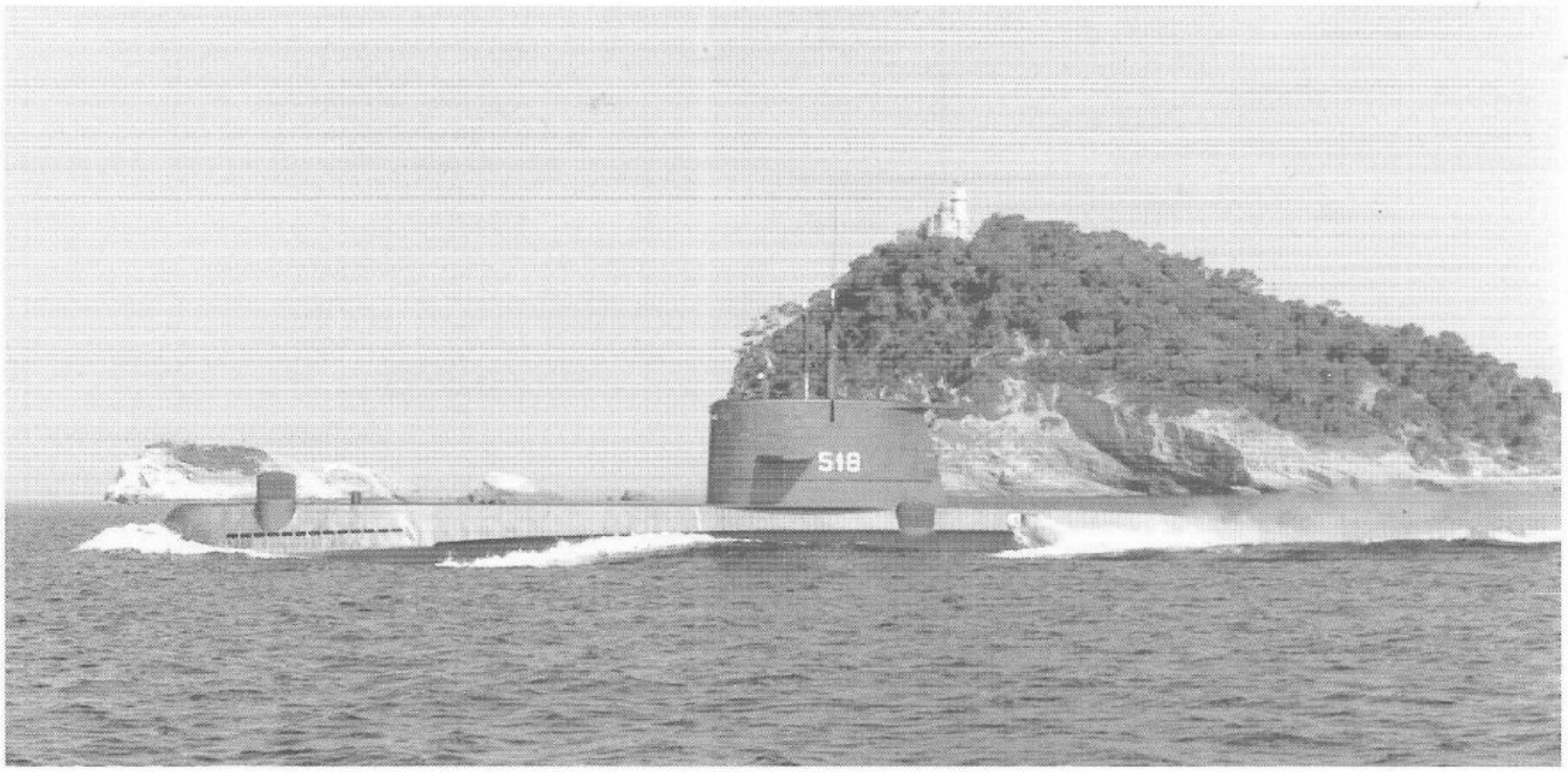
USEA RS-100 emergency transponder
All 'Sauro' class submarines are fitted with the RS-100 emergency localisation device, an underwater transponder which automatically responds to suitable acoustic interrogation pulses. There is a cylindrical piezoelectric transducer installed on the outside of the hull which is sensitive to acoustic pulses at three frequencies in the 6 to 10 kHz band and when a pulse at one of these frequencies and of the expected duration is received, a corresponding pulse at the same frequency is sent back by the transponder.

Manufacturer/Contractor
USEA, La Spezia, Italy.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

SMA MM/BSN-716 (SACTIS)
SACTIS (Submarine ACTion Information System) was developed by SMA for 'Sauro' class submarines in collaboration with Datamat. Two versions are produced and SACTIS 1 (Italian Navy designation MM/BSN-716(V)1) is in the early 'Sauro' class boats. Principal functions are:
(a) automatic data acquisition from sonars, passive ranging system, search and attack periscopes, radar, ESM, navigation system and depth sounder.
(b) manual data input
(c) real-time computation of ship's position and target position (from bearing data only)
(d) data display (raw and processed) with four different presentations: unfiltered situation; tactical situation; time/bearing display; tactical operation tabular evaluation
(e) calculation and display of data for typical



Nameship of the class, Nazario Sauro *(S 518)* (Italian Navy)

manoeuvres such as screen or barrage penetration, evasion, target interception or collision course, approach and divergence routes, closest point of approach (CPA)
(f) data and event recording
(g) playback for training and analysis.

There are 2/3 display groups with vertical CRT displays and keyboards for data input and system management, with separate alphanumeric tote displays above the situation display CRTs; a central processor unit based on a Rolm MSE 14 digital computer; disk memories; a printer; a specially designed interface unit for input/output between SACTIS and the various sensors. The displays are arranged side by side to form an operating console and up to 30 separate targets can be displayed, from which individual track histories can be selected for examination and 10 of them presented as filtered targets. Main sensors connected to the system include the BPS-704 radar, IPD-70S sonar system and the Thetis electronic warfare system.

Manufacturers/Contractors
SMA SpA, Florence, Italy (main contractor).
Datamat SpA, Rome, Italy (software).

RADAR

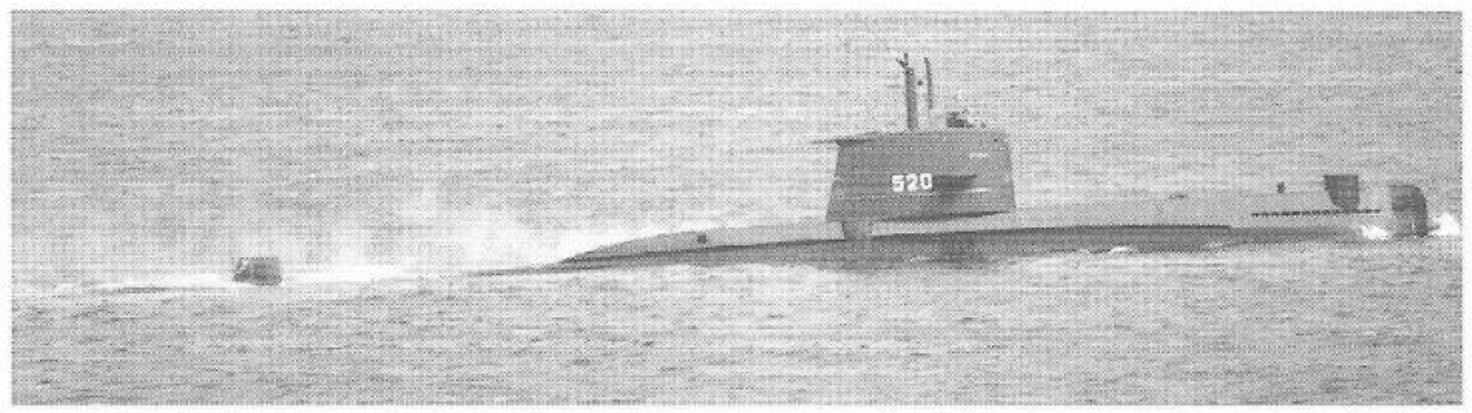
MM/BPS-704
The MM/BPS-704 (company designation 3RM20) search and navigation radar has similar characteristics to the MM/SPN-703 surface ship radar, using the same 20 kW transmitter and with the same pulse length/PRF combinations. The antenna is specially designed to resist high pressure (up to 60 kg/cm²) and is mounted on a telescopic mast.

Specifications
Antenna span: 1 m
Peak power: 20 kW
Beamwidth:
  horizontal: 2.2°
  vertical: 11°
Gain: At least 27 dB
Noise figure: <11 dB
Scan rate: 25 rpm

Manufacturer/Contractor
SMA — Segnalamento Marittimo ed Aereo, Florence.

SONARS

Alenia/Elsag IPD70/S integrated sonar
The IPD70/S integrated sonar suite is a digital version of the analogue IPD70, which was originally installed in the 'Sauro' class. IPD70/S comprises:



Leonardo da Vinci *(S 520)* (H & L van Ginderen Collection)

(a) IN-100A high-precision LF interceptor which detects active sonar emissions at ranges of several tens of kilometres, and measures bearing, pulse length, frequency and repetition rate to classify enemy sonars.
(b) ISO-100 panoramic HF interceptor which detects sonar emissions in the medium- and high-frequency ranges, evaluating bearing, frequency, amplitude, length and repetition rates of intercepted pulses.
(c) TS-100 long-range directional/omnidirectional underwater telephone, which uses operating frequencies and modulation techniques that comply with NATO standards.
(d) MD-100 passive rangefinding sonar.
A digital console and processor with two high-resolution raster scan monitors with image memories are used to control operations, display processed information and interface the command and control subsystem.

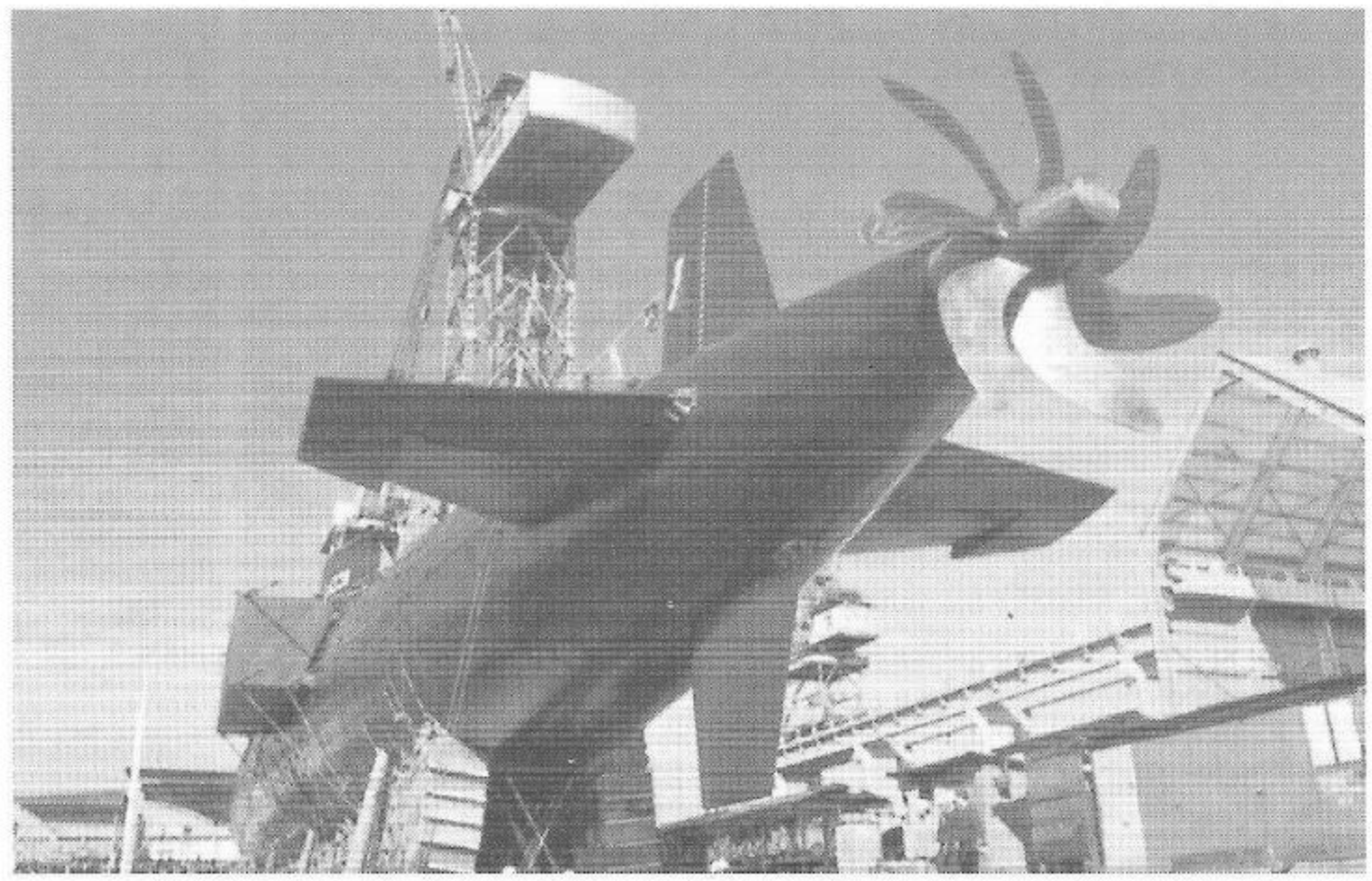
Manufacturer/Contractor
Alenia Elsag Sistemi Navali SpA, Rome Italy.

Thomson-Sintra towed array
Nazario Sauro is testing a Thomson Sintra towed array.

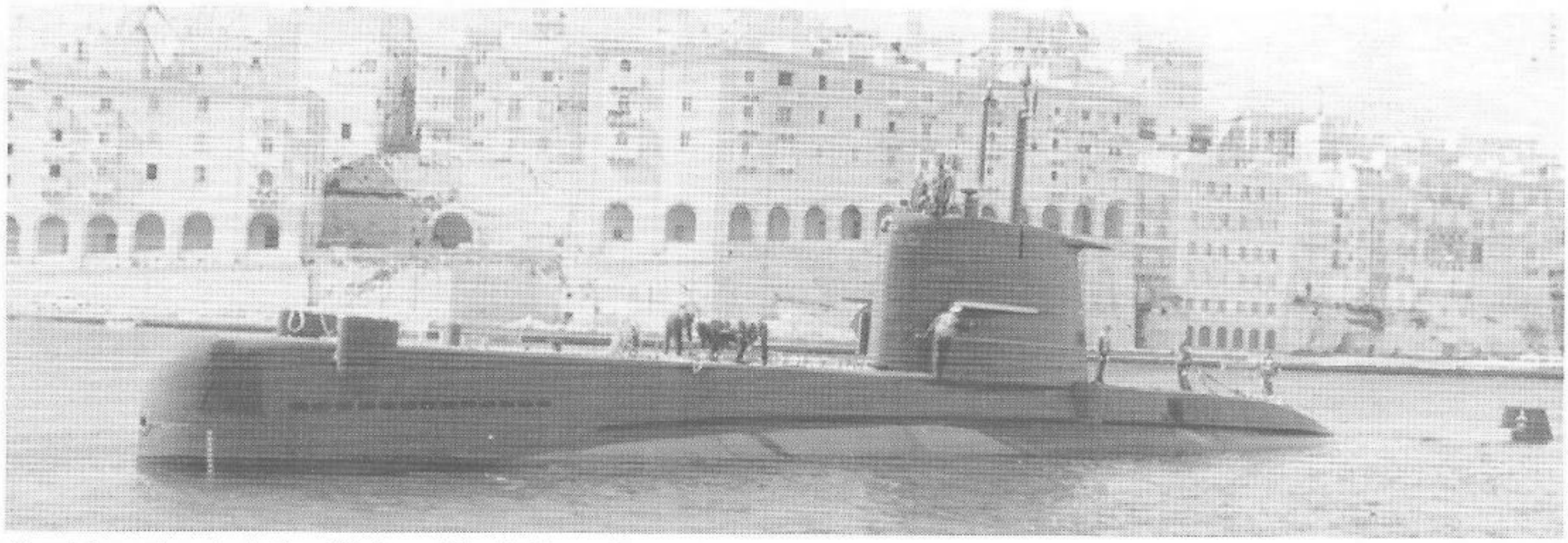
PERISCOPES

Search
Pilkington Optronics CK 31 search.

Attack
Pilkington Optronics CH 81 attack.



'Sauro' class is fitted with a seven-bladed, skew-back propeller (Fincantieri)



'Sauro' class submarine in Grand Harbour, Malta (H & L van Ginderen Collection)

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 3 Fincantieri GMT 210 SM diesels; 2.64 MW (3,350 hp(m)) sustained
Alternators: 3 alternators; 2.16 MW
Electric motor: 1 motor; 2.36 MW (3,210 hp(m))
Shafts: 1 shaft
Propeller: 7-bladed, skew-back
Battery: 2 groups, each of 148 CGA cells; 6,000 Ah at 1 h rate

FURTHER INFORMATION

PROGRAMME

In 1939 the Italian Navy had the largest submarine fleet in the world, but large numbers were lost in the war, and those that survived were in poor condition. The peace treaty banned Italy from building or operating submarines, but Italy's membership of NATO, coupled with the intensification of the Cold War led to this prohibition being lifted in 1952. Like many other navies the Italians subsisted for many years on ex-US Navy 'Gato', 'Balao' and 'Tang' class fleet submarines, but then in the late 1950s a design was prepared for a small (590 t submerged displacement) submarine, the 'Toti' class, of which four were built; they were commissioned in 1968/69 and the last one was retired in 1996.

The 'Sauro' class is considerably larger than the Totis and the first pair were originally ordered in 1967 but were cancelled in the following year due to budgetary problems. They were reinstated in the building programme in 1972. Further problems arose with their batteries and the discrepancy in the commissioning dates of *Nazario Sauro* and *Fecia di Cossato* was due to problems over the main batteries. *Fecia di Cossato* was provided with a new CGA battery which proved to be satisfactory and *Nazario Sauro* was then similarly fitted.

MODERNISATION

All have undergone a modernisation programme: *Fecia di Cossato* in 1990, *Nazario Sauro* in 1991, *Guglielmo Marconi* in 1992 and *Leonardo da Vinci* in 1993. In this they have been given new batteries with a greater capacity, some auxiliary machinery has been replaced and the habitability has been improved.

TRIALS

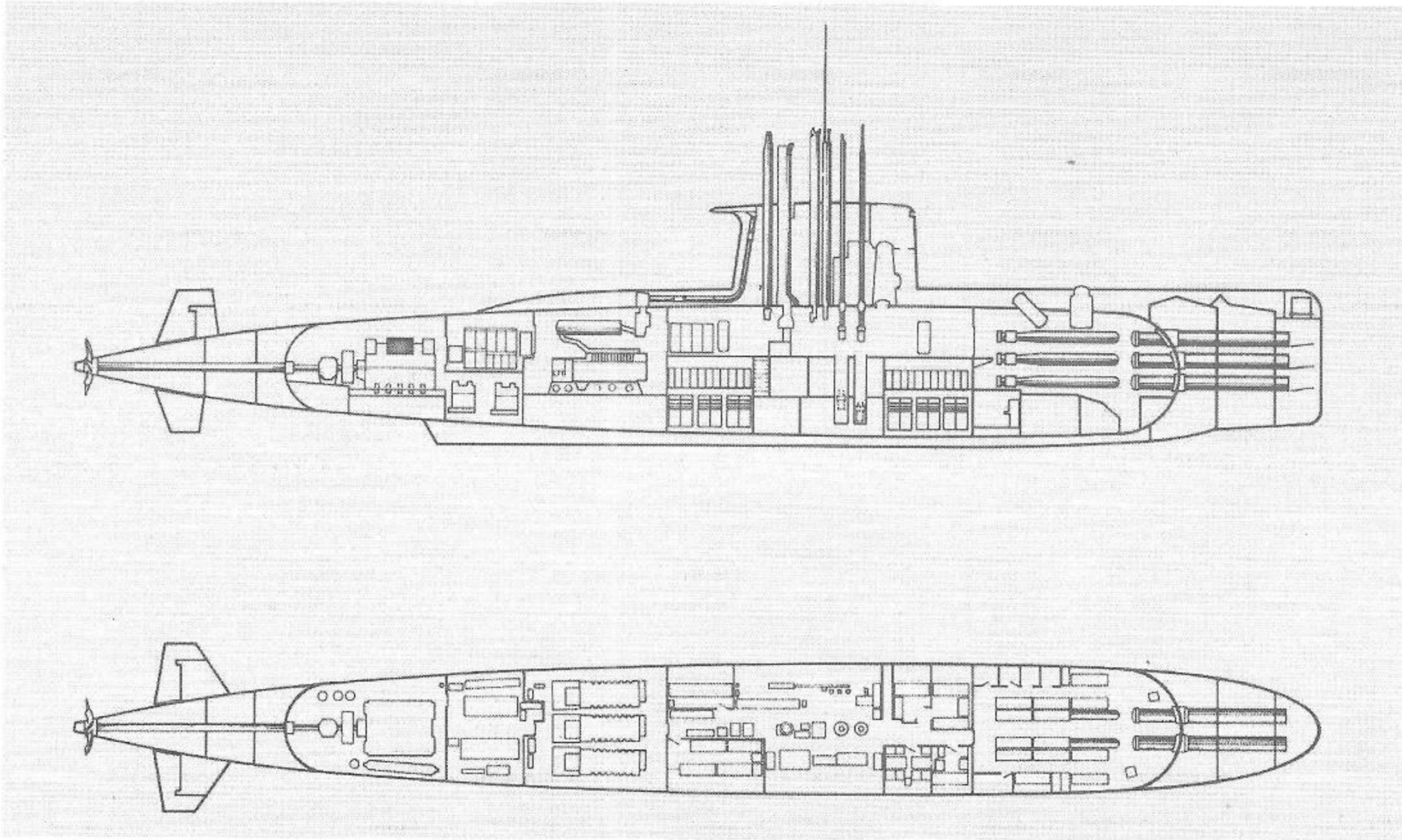
Nazario Sauro is trialling a Thomson-CSF clip-on towed array and new weapons control system, and is being manned by a reduced crew. It is not currently combat qualified.

Plans have also been announced to test an AIP system in *Fecia di Cossato,* although this plan may be reconsidered in view of the decision to build German Type 212 boats.

OPERATIONAL

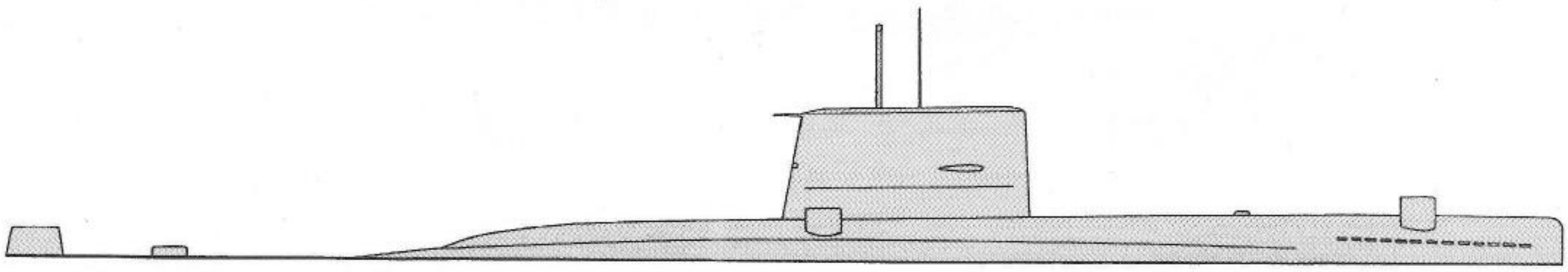
The reliability has been considerably improved by the mid-life modernisation programme.

Leonardo da Vinci was damaged in a dived collision with the destroyer *Ardito* (D 550) in 1992.



'Sauro' class (Fincantieri)

IMPROVED SAURO



Improved Sauro (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Italy

Class: IMPROVED SAURO

Built: 4
In service: 4

	S 522-523	S 524-525
Displacement		
surfaced	1,476 t	1,662 t
submerged	1,662 t	1,862 t
Dimensions		
length	64.4 m (211.2 ft)	66.4 m (217.8 ft)
beam	6.8 m (22.3 ft)	6.8 m (22.3 ft)
draught	5.6 m (18.4 ft)	5.6 (18.4 ft)

Speed:
surfaced: 11 kts
snorting: 12 kts
submerged: 19 kts
Range:
surfaced: 11,000 n miles at 11 kts
submerged: 250 n miles at 4 kts
Diving depth:
test: 300 m (985 ft)
crushing: 600 m (1,970 ft)
Endurance: 45 days (possibly increased in second pair)

Complement: 50 (7 officers)

SUBMARINES

SALVATORE PELOSI (S 522)
Builder Fincantieri, Monfalcone, Italy
Laid down 24 May 1984
Launched 29 Dec 1986
Commissioned 14 Jul 1988

GIULIANO PRINI (S 523)
Builder Fincantieri, Monfalcone, Italy
Laid down 30 May 1985
Launched 12 Dec 1987
Commissioned 11 Nov 1989

PRIMO LONGOBARDO (S 524)
Builder Fincantieri, Monfalcone, Italy
Laid down 19 Dec 1991
Launched 20 Jun 1992
Commissioned 20 May 1994

GIANFRANCO GAZZANA PRIAROGGIA (S 525)
Builder Fincantieri, Monfalcone, Italy
Laid down 12 Nov 1992
Launched 26 Jun 1993
Commissioned Mar 1995

WEAPONS SYSTEMS

TUBES

Six 533 mm (21 in) bow tubes; swim-out discharge. Total weapon load, 12.

TORPEDOES

Whitehead A 184

The Whitehead A 184 is a dual-purpose (surface vessels and submarines) wire-guided torpedo with a 250 kg HBX warhead with magnetic influence and impact fuzes. The weapon is capable of two speeds, 24 and 36 knots and is launched by swimming-out. Commands carried by the guidance wires include: course, depth, acoustic mode (active, passive and combined), enabling range, stratum allowed, speed, impact and influence fuze setting, torpedo stop. Replies from the weapon include: course, distance, depth, acoustic mode, speed, other data on interrogation. The A 184 is used in all Italian submarines, but the only export order has been from Peru.

Specifications
Length: 6 m (19.69 ft)
Diameter: 533 mm (21 in)
Weight: 1,265 kg (2,789 lb)
Warhead: 250 kg (551 lb) HBX HE
Propulsion: Electric
Homing: Active/passive
Performance: 13.7 n miles (25 km) at 24 kts; 9.2 n miles (17 km) at 36 kts
Speed: 24 or 36 kts

Manufacturer/Contractor
Whitehead SpA, Salviano, Italy.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Elettronica BLD 727

Elettronica BLD-727 radar warning set. There are two antennas; one on a mast, the other in the search periscope.

USEA RS-100 emergency transponder

All 'Sauro' class submarines are fitted with the RS-100 emergency localisation device, an underwater transponder which automatically responds to suitable acoustic interrogation pulses. There is a cylindrical piezoelectric transducer installed on the outside of the hull which is sensitive to acoustic pulses at three frequencies in the 6 to 10 kHz band and when a pulse at one of these frequencies and of the expected duration is received, a corresponding pulse at the same frequency is sent back by the transponder.

Manufacturer/Contractor
USEA, La Spezia, Italy.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

SMA MM/BSN 716(V)2 SACTIS

SACTIS (Submarine ACTion Information System) was developed by SMA for 'Sauro' class submarines in collaboration with Datamat. Two versions are produced and SACTIS 2 (Italian Navy designation MM/BSN-716(V)2) is in the later 'Sauro' class boats. Principal functions are:

(a) automatic data acquisition from sonars, passive ranging system, search and attack periscopes, radar, ESM, navigation system and depth sounder.
(b) manual data input
(c) real-time computation of ship's position and target position (from bearing data only)
(d) data display (raw and processed) with four different presentations: unfiltered situation; tactical situation; time/bearing display; tactical operation tabular evaluation
(e) calculation and display of data for typical

manoeuvres such as screen or barrage penetration, evasion, target interception or collision course, approach and divergence routes, closest point of approach (CPA)
(f) data and event recording
(g) playback for training and analysis.
The hardware comprises: two or three display groups which have vertical CRT displays and keyboards for data input and system management, with separate alphanumeric tote displays above the situation display CRTs; a central processor unit based on a Rolm MSE 14 digital computer; disk memories; a printer; a specially designed interface unit for input/output between SACTIS and the various sensors. The displays are arranged side by side to form an operating console and up to 30 separate targets can be displayed, from which individual track histories can be selected for examination and 10 of them presented as filtered targets. Main sensors connected to the system include the BPS-704 radar, IPD-70S sonar system and the Thetis electronic warfare system.

Unlike SACTIS 1, SACTIS 2 includes provision for connection with the submarine's A 184 torpedo fire-control system, inclusion of the ELT/810 sonar prediction system, and connection to a Link 11 receiver. There is also extended computer capacity and a third operator position at the SACTIS console.

Manufacturer/Contractor
SMA SpA, Florence, Italy (main contractor).
Datamat SpA, Rome, Italy (software).

RADAR

SMA MM/BPS-704
The MM/BPS-704 (company designation 3RM20) search and navigation radar has similar characteristics to the MM/SPN-703 surface ship radar, using the same 20 kW transmitter and with the same pulse length/PRF combinations. The antenna is specially designed to resist high pressure (up to 60 kg/cm²) and is mounted on a telescopic mast. There is also a periscope radar for attack ranging.

Specifications
Antenna span: 1 m
Peak power: 20 kW
Beamwidth:
horizontal: 2.2°
vertical: 11°
Gain: At least 27 dB
Noise figure: <11 dB
Scan rate: 25 rpm

Manufacturer/Contractor
SMA — Segnalamento Marittimo ed Aereo, Florence.

SONARS

Alenia Elsag IPD 70/S integrated sonar
The IPD70/S integrated sonar suite is a digital version of the analogue IPD70, which was originally installed in the 'Sauro' class. IPD70/S comprises:

Giuliano Prini *(S 523)* (H & L van Ginderen Collection)

(a) IN-100A high-precision LF interceptor which detects active sonar emissions at ranges of several tens of kilometres, and measures bearing, pulse length, frequency and repetition rate to classify enemy sonars.
(b) ISO-100 panoramic HF interceptor which detects sonar emissions in the medium- and high-frequency ranges, evaluating bearing, frequency, amplitude, length and repetition rates of intercepted pulses.
(c) TS-100 long-range directional/omnidirectional underwater telephone, which uses operating frequencies and modulation techniques that comply with NATO standards.
(d) MD-100 passive rangefinding sonar.

A digital console and processor with two high resolution raster scan monitors with image memories are used to control operations, display processed information and interface the command and control subsystem.

Manufacturer/Contractor
Alenia Elsag Sistemi Navali SpA, Rome, Italy.

NAVIGATION

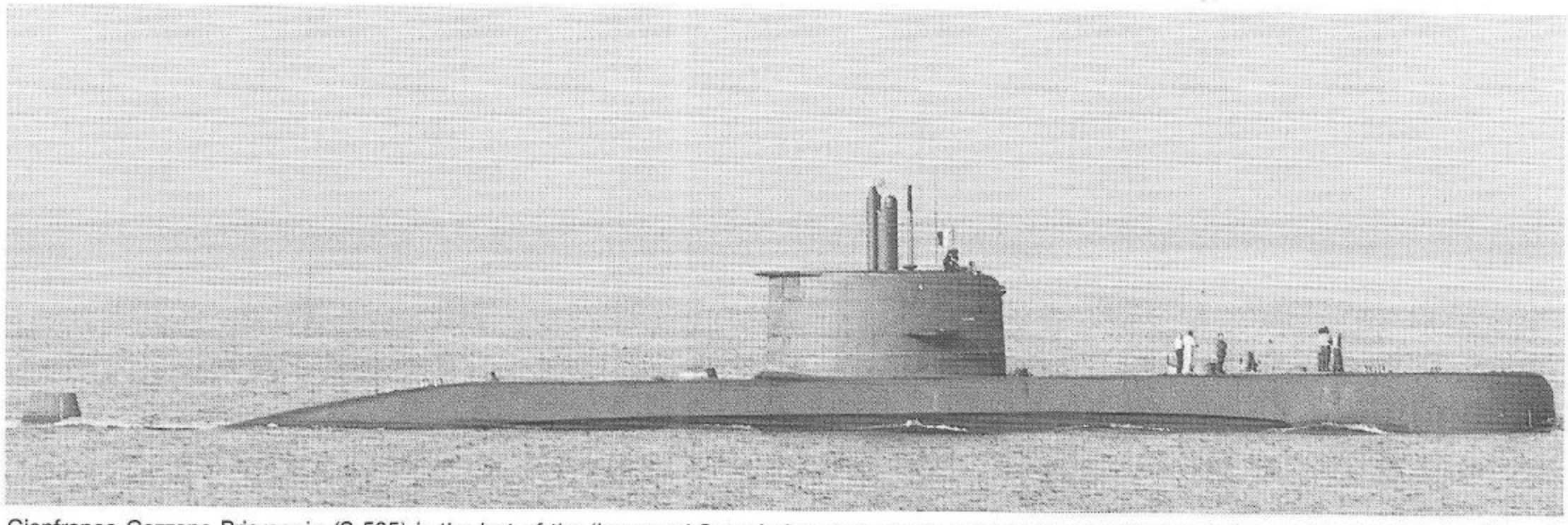
Litton Italia PL 41 inertial navigation
Ferranti autopilot
Omega
Transit.

PERISCOPES

Attack
Kollmorgen S 76 Model 322 with laser rangefinder and ESM.

Search
Kollmorgen S 76 Model 323 with radar rangefinder and ESM.

Manufacturer/Contractor
Kollmorgen Electro Optical, Northampton, Massachussets, USA.



Gianfranco Gazzana Priaroggia *(S 525) is the last of the 'Improved Sauro' class to be built and may also be the last Italian-designed submarine* (Giorgio Ghiglione)

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 3 Fincantieri GMT 210.16 SM diesels; 4.7 MW (6,400 hp(m)) sustained

Alternators: 3 alternators; 2.16 MW
Electric motor: 1 motor; 3.14 MW (4,270 hp(m))
Shaft: 1 shaft

Propeller: 7-bladed, skew-back
Battery: 2 groups of 148 cells each; 6,500 Ah

FURTHER INFORMATION

PROGRAMME

Continuing its policy of having two submarines under construction at any one time, the Italian Navy followed the 'Sauro' class with four boats of the 'Improved Sauro' type.

S 522 and S 523 were ordered in March 1983, but the second pair was not ordered until five years later, in July 1988.

DESIGN

The first pair are 0.5 m (1.64 ft) longer than the 'Sauro' class, which has enabled a central bulkhead to be included for escape purposes. The extra length also enables Sub-Harpoon missiles to be accommodated, although no missiles have actually been purchased yet.

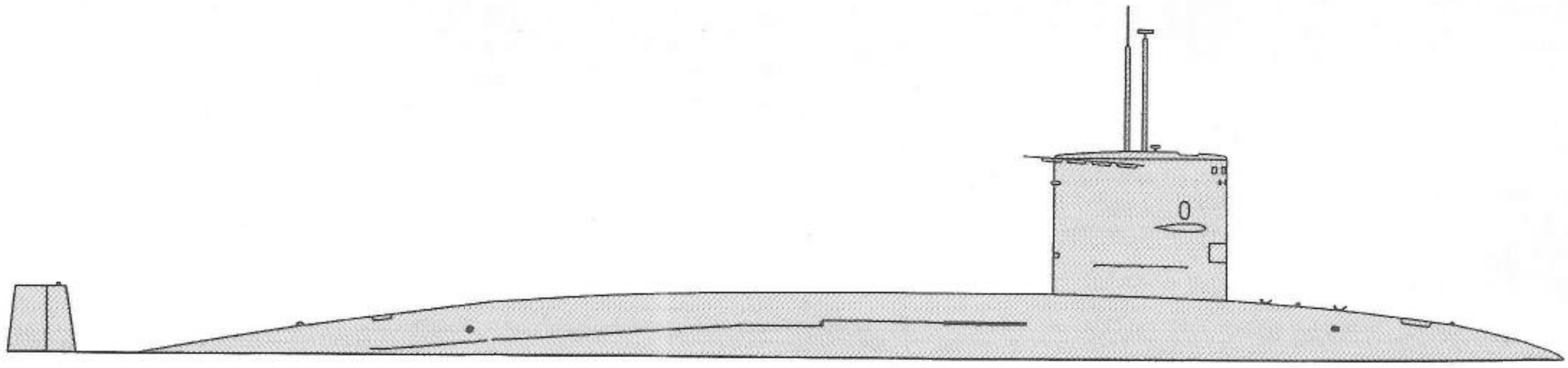
The pressure hull is constructed from HY 80 steel, which increases the diving performance. The wave-contour snort head has a very low radar profile.

The hulls of the second pair are slightly longer still and they are the first Italian submarines to be covered in anechoic tiles. All four are to be fitted with clip-on towed sonar arrays in due course, the system being currently under test in *Nazario Sauro*.

THE FUTURE

The Italian plan was to continue the policy of steady progression of Italian designs with the next being designated the S90, which would have had the same propulsion plant as the last two of the 'Improved Sauros' but with added performance. This plan has, however, been changed and it is now planned to produce two German Type 212s at Fincantieri, Monfalcone, with certain modifications to meet Italian requirements, possibly including air-independent propulsion (AIP). Under this plan the first hull would be laid down in 1998, followed by the second five years later.

YUUSHIO



Yuushio (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Japan

Class: YUUSHIO

Built: 10
In service: 10

Displacement:
surfaced: 2,200 t (SS 573, SS 575, SS 576); 2,250 t (SS 574 and SS 577-582)
submerged: 2,450 t

Dimensions
Length: 76 m (249.3 ft)
Beam: 9.9 m (32.5 ft)
Draught: 7.4 m (24.3 ft)

Speed:
surfaced: 12 kts
submerged: 24 kts
Diving depth: 275 m (900 ft)

Complement: 75 (10 officers)

SUBMARINES

YUUSHIO (SS 573)
Builder Mitsubishi, Kobe, Japan
Laid down 3 Dec 1976
Launched 29 Mar 1979
Commissioned 26 Feb 1980

MOCHISHIO (SS 574)
Builder Kawasaki, Kobe, Japan
Laid down 9 May 1978
Launched 12 Mar 1980
Commissioned 5 Mar 1981

SETOSHIO (SS 575)
Builder Mitsubishi, Kobe, Japan
Laid down 17 Apr 1979
Launched 10 Feb 1981
Commissioned 17 Mar 1982

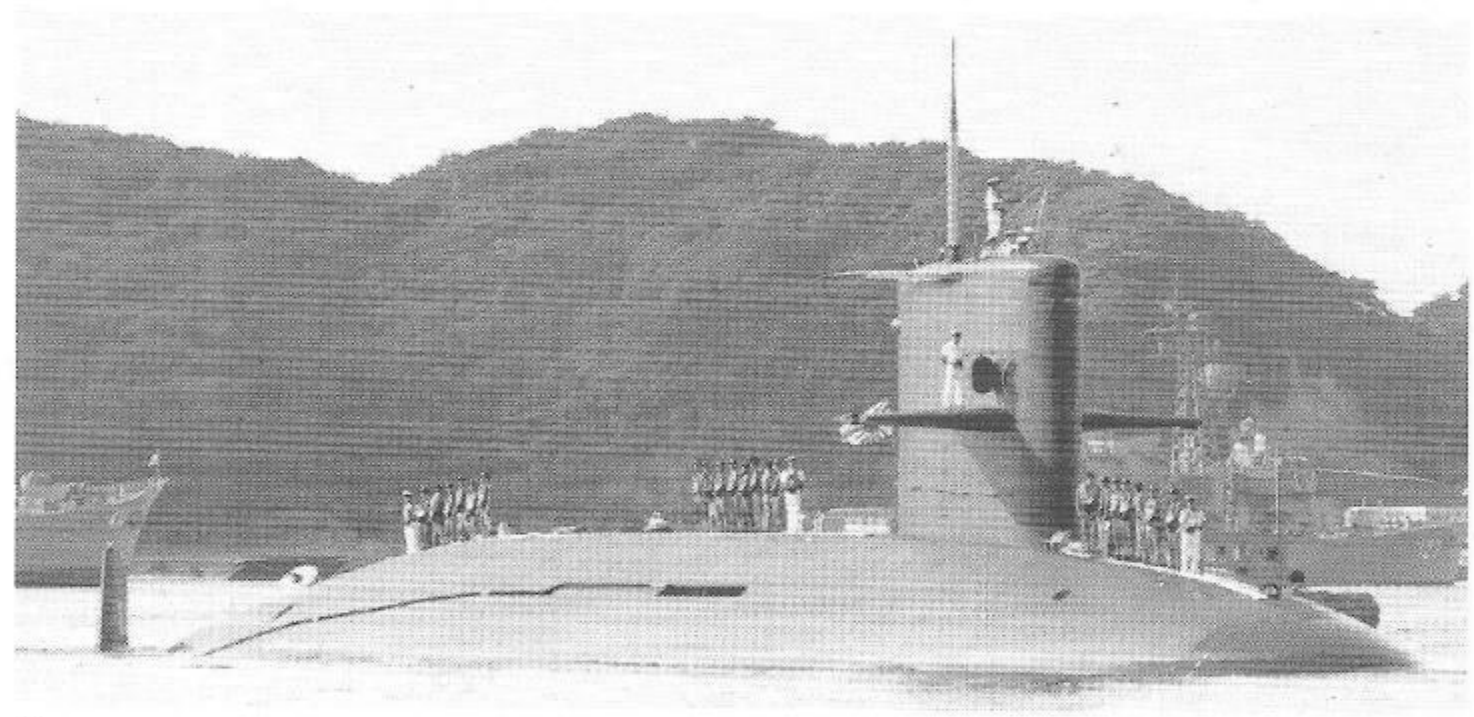
OKISHIO (SS 576)
Builder Kawasaki, Kobe, Japan
Laid down 17 Apr 1980
Launched 5 Mar 1982
Commissioned 1 Mar 1983

NADASHIO (SS 577)
Builder Mitsubishi, Kobe, Japan
Laid down 16 Apr 1981
Launched 27 Jan 1983
Commissioned 6 Mar 1984

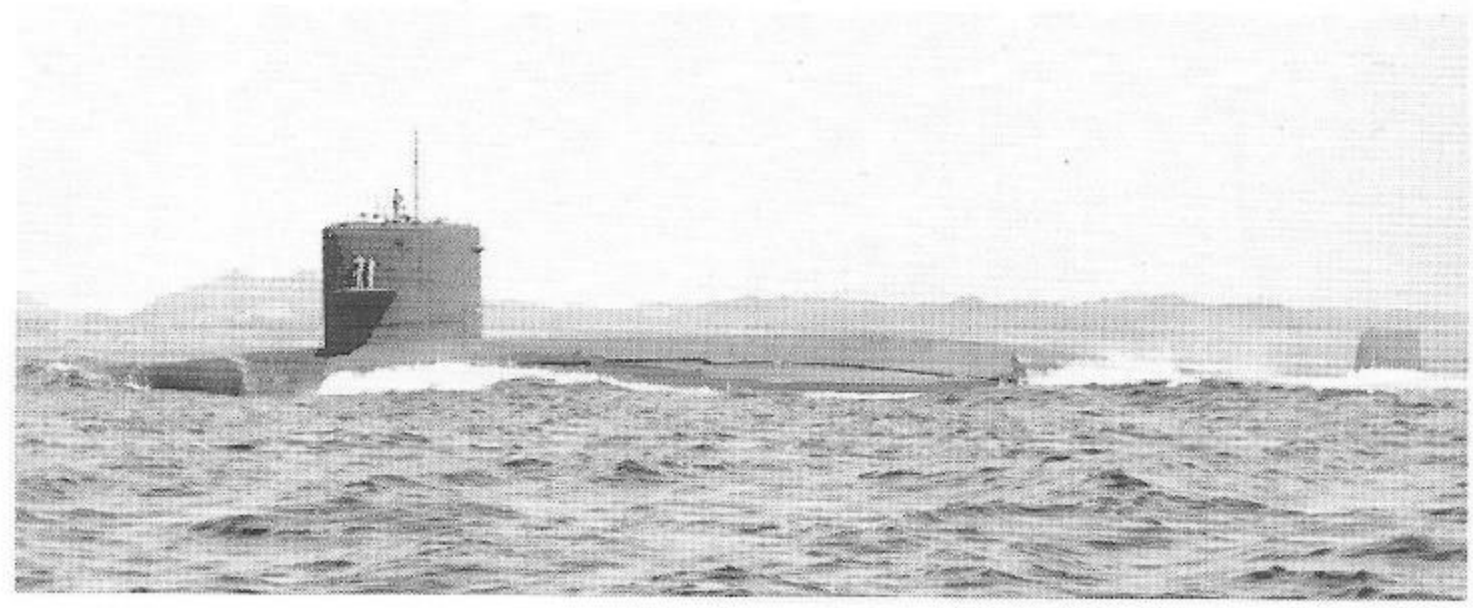
HAMASHIO (SS 578)
Builder Kawasaki, Kobe, Japan
Laid down 8 Apr 1982
Launched 1 Feb 1984
Commissioned 5 Mar 1985

AKISHIO (SS 579)
Builder Mitsubishi, Kobe, Japan
Laid down 15 Apr 1983
Launched 22 Jan 1985
Commissioned 5 Mar 1986

TAKESHIO (SS 580)
Builder Kawasaki, Kobe, Japan
Laid down 3 Apr 1984
Launched 9 Feb 1986
Commissioned 3 Mar 1987



Hamashio *(SS 578). Note the lowered whip antenna with camouflaged covering on starboard side of the sail* (H & L van Ginderen Collection)



Nadashio *(SS 577)* (H & L van Ginderen Collection)

YUKISHIO (SS 581)
Builder Mitsubishi, Kobe, Japan
Laid down 11 Apr 1985
Launched 23 Jan 1987
Commissioned 11 Mar 1988

SACHISHIO (SS 582)
Builder Kawasaki, Kobe, Japan
Laid down 11 Apr 1986
Launched 17 Feb 1988
Commissioned 24 Mar 1989

WEAPONS SYSTEMS

ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Sub-Harpoon

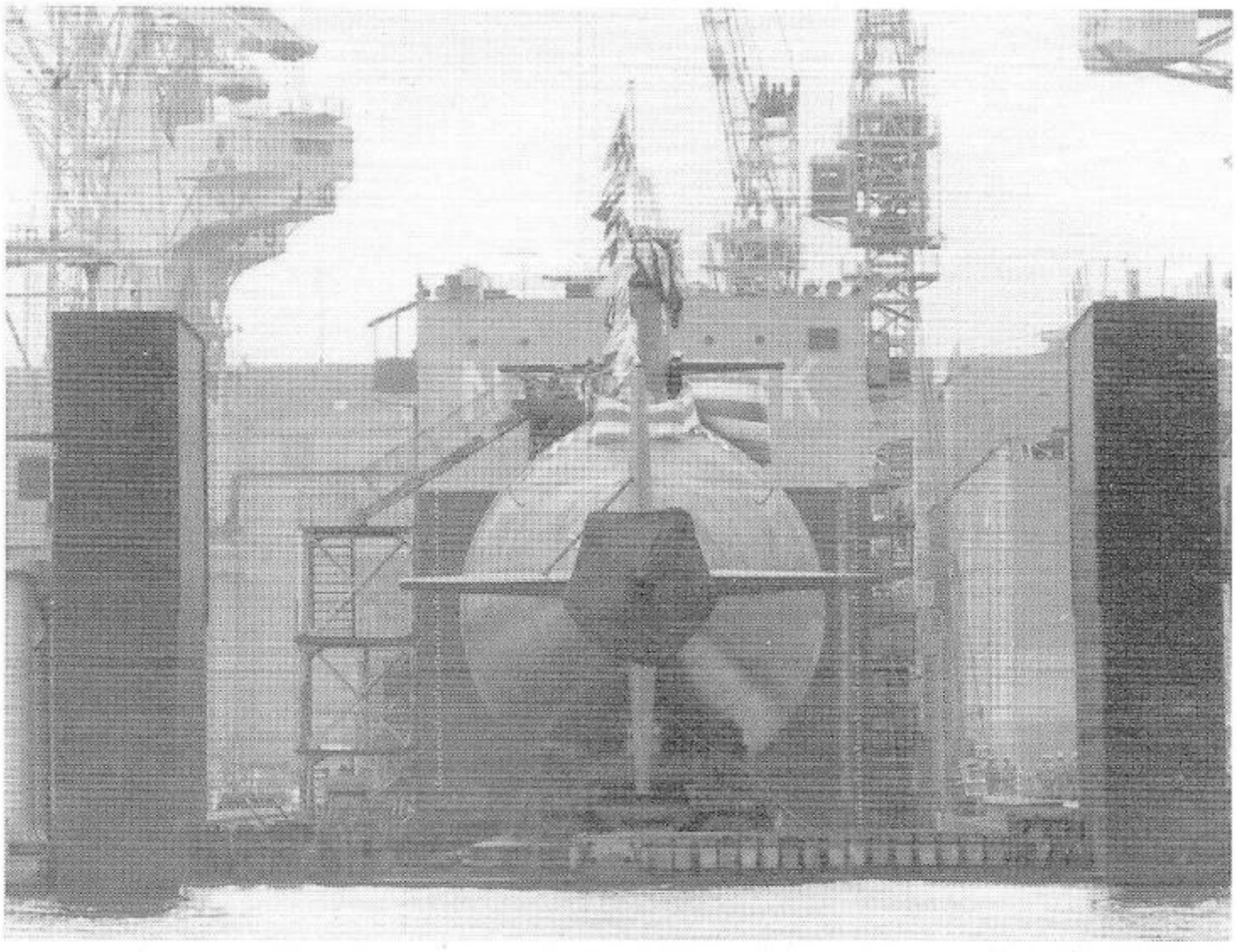
Sub-Harpoon arms all submarines in the class. Block 1C includes a number of options, including the ability to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses, or to approach the target indirectly, using up to three preselected waypoints. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).



Setoshio *(SS 575) about to be launched on 10 February 1981. Despite the cover, it appears that the propeller is a five-bladed, non-skewed type* (H & L van Ginderen Collection)

TUBES

Six 533 mm (21 in) torpedo tubes; amidships.
Total weapon load, 20 torpedoes/missiles.

TORPEDOES

Type 89

The Type 89 has been developed as the equivalent to the US Navy's Mk 48 ADCAP. It is powered by a thermal propulsion system and has a reported maximum speed of 70 knots, making it one of the fastest torpedoes in the world.

Specifications

Homing: Active/passive homing
Range: 27 n miles (50 km) at 40 kts; 21 n miles (38 km) at 55 kts
Warhead: 267 kg (590 lb)
Max operating depth: 900 m (2,950 ft)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

ZLR 3/5

ZLR-3/5 is a radar warning system, broadly equivalent to the US Navy's WLR-8. The latter covers the 50 MHz to 18 GHz band and provides automatic classification and identification of signals, and can trigger alarms against specified threats.

ZLR-4/6

ZLR-4/6 is a threat warning system broadly equivalent to the US Navy's WLR-1G.

COMMAND AND CONTROL SYSTEMS

RADAR

ZPS-6

The surface search radar is the I-band ZPS-6.

Manufacturer/Contractor

JRC Tokki, Japan.

SONARS

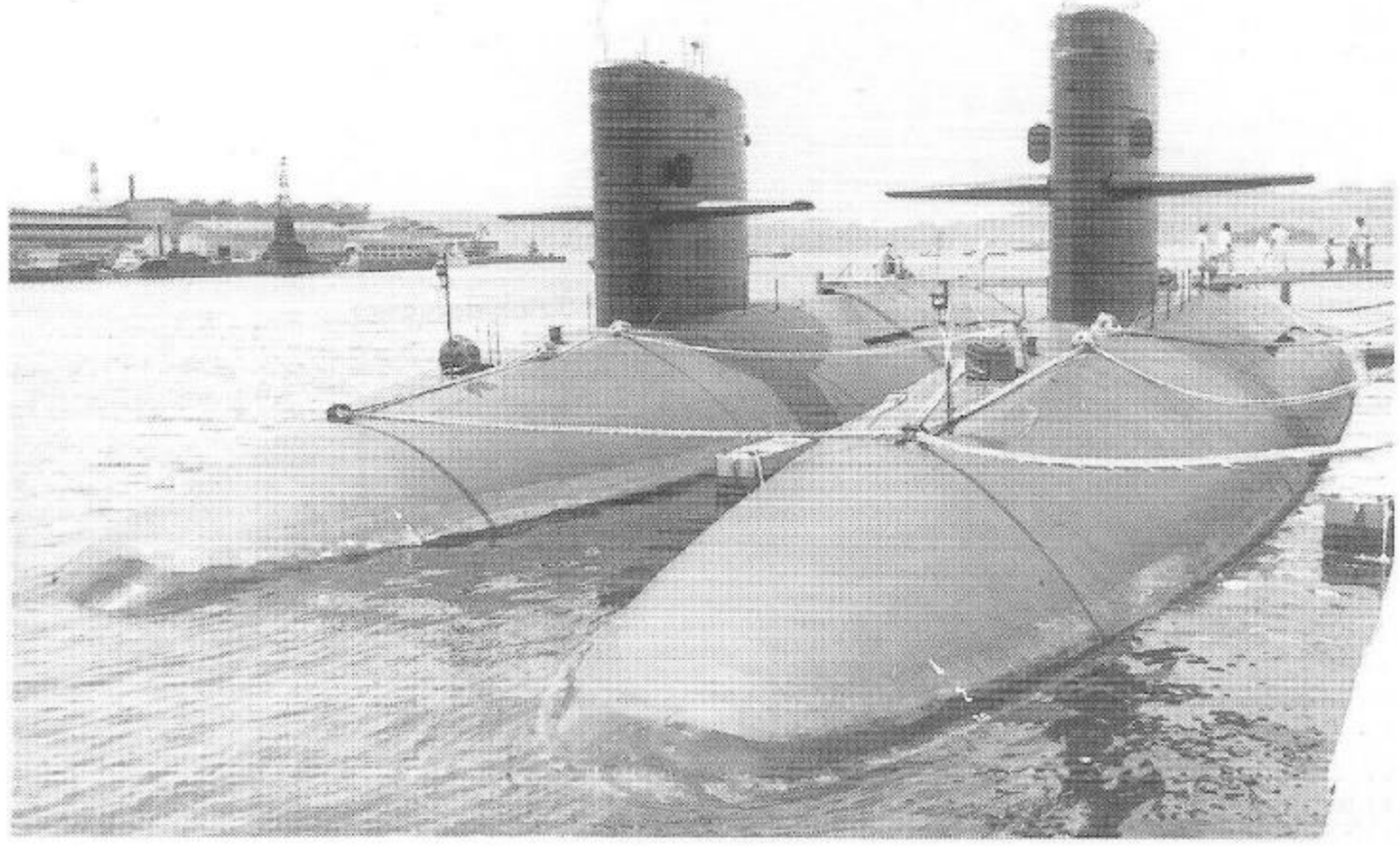
Hughes/Oki ZQQ-4, ZQQ-5, ZQR-1

The Hughes/Oki ZQQ-4 is a medium/low-frequency, bow-mounted spherical, passive/active search and attack sonar which originally equipped the 'Yuushio' class whose design is based on that of the US BQS-4. ZQQ-4 incorporates a clip-on towed linear passive intercept array, the ZQR-1, which is a very low-frequency, passive, towed array sonar similar to the US AN/BQR-15.

The latest sonar is the Hughes/Oki ZQQ-5B medium/low-frequency, active/passive search and attack sonar. This sonar suite equips the submarines of the 'Harushio' class 'as built' and is being retrofitted to the 'Yuushio' class. It incorporates a Japanese towed array which retracts into a housing running along the casing.

Manufacturer/Contractor

Hughes/Oki, Japan.



Yuushio *(SS 573), first submarine in its class, left alongside* Yaeshio *(SS 572) the last of the previous 'Uzushio' class* (H & L van Ginderen Collection)

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 Kawasaki-MAN V8V24/30ATL; 5 MW (6,800 hp(m))
Electric motors: 2 Fuji; 5.3 MW (7,200 hp(m))
Shafts: 1
Battery: 2 groups, each of 480 Nihon-Denchi cells

FURTHER INFORMATION

PROGRAMME

The Japanese Maritime Self-Defense Force (JMSDF) has followed steady and consistent submarine design and construction policies since the first post-war submarines — *Oyashio* (1,420 t submerged) — was launched in 1957. All these early boats had long, thin hulls and twin propellers until the 'Oshio' class (2,100 t submerged), which entered service in 1965-69, which was followed by the single-propeller 'Uzushio' class, with an Albacore-type (teardrop) hull which entered service between 1971 and 1978.

First of class, *Yuushio* (SS 573) was approved in FY75 and entered service in 1980. Thereafter, with almost clockwork precision, one per year entered service in March of each year until the tenth and last, *Sachishio* (SS 582), in 1989.

DESIGN

Japan does not export military equipment and less is known about its submarines than those of any other country, including Russia and China. In general, however, they are among the most advanced diesel-electric designs in the world. The overall design is purely Japanese, as is most of the equipment, particularly the electronics and the torpedoes.

Most early Japanese ASW submarines were fitted with various types of US sonar systems, following which there were a number of adaptations of US sets: the Hughes/Oki ZQQ 1 passive sonar, for example, was comparable to the US BQQ-2. Japan is now developing its own designs, using Japanese state-of-the-art digital processing and display technology.

The main weapon is, however, the US Sub-Harpoon, while sonars are manufactured by a joint US-Japanese company (Hughes/Oki). Diesel engines were originally MAN designs made under licence by Kawasaki, but are now Kawasaki's own designs.

The 'Yuushio' class is an enlarged version of the previous 'Uzushio' class and is of double-hull construction. The towed array is stowed in a conduit on the starboard side of the casing. The later units of the class have pressure hulls constructed of NS 80 steel, with an 80 kg/mm² yield strength.

MODERNISATION

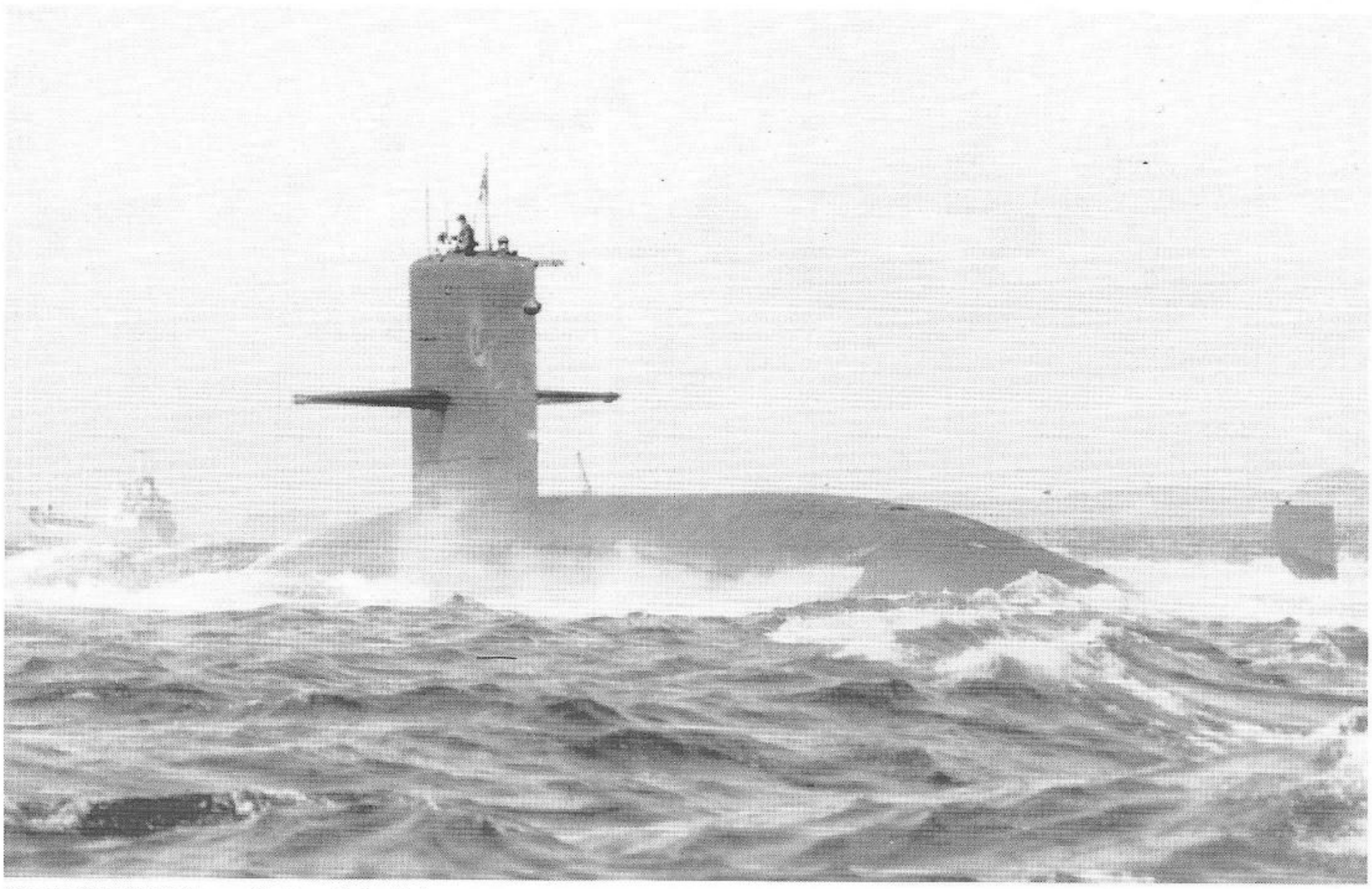
Towed sonar array fitted in *Okishio* (SS 573) in 1987 and now back-fitted to others in the class. ZQQ 5 is being retrofitted. All except *Yuushio* now have Harpoon.

OPERATIONAL

In July 1988 *Nadashio* (SS 577) was running on the surface when it collided with a fishing boat, causing considerable loss of life. The damage to the submarine was repaired.

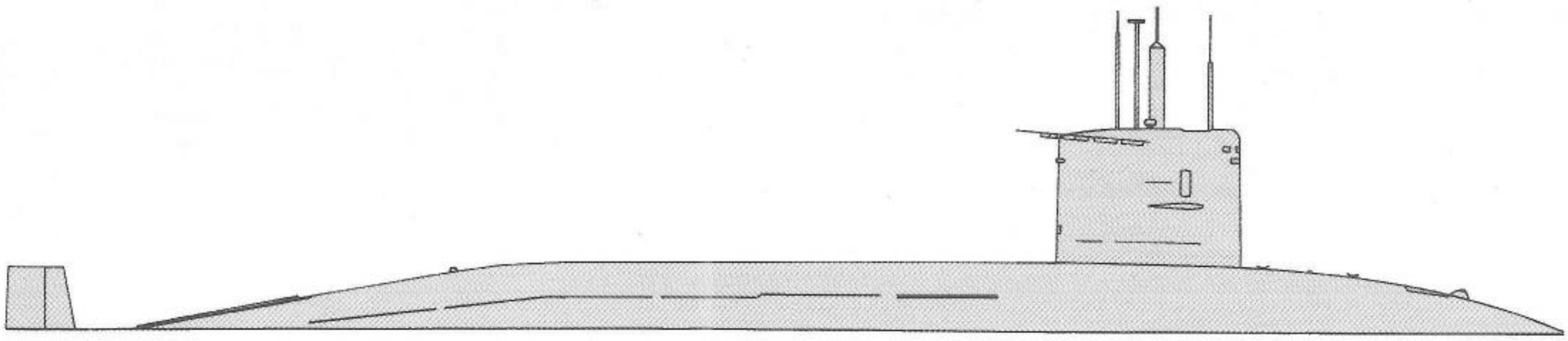
THE FUTURE

Following the normal JMSDF pattern, the 'Yuushio' class will be replaced by a new class, which is essentially an 'Improved Harushio' design. The first of class was laid down in 1994 and is due to enter service in 1998. This class, as yet unnamed, will have a surface displacement of 2,700 t (300 t more than the 'Harushio' class) and may include a Kockums-Sterling AIP unit.



Okishio *(SS 576)* (H & L van Ginderen Collection)

HARUSHIO



Harushio (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Japan

Class: HARUSHIO

Built: 6
In service: 6
Building: 1

Displacement:
surfaced: 2,450 t (SS 589 — 2,560 t)
submerged: 2,750 t (SS 589 — 2,850 t)

Dimensions
Length: 77 m (252.6 ft)
Beam: 10 m (32.8 ft)
Draught: 7.7 m (25.3 ft)

Speed:
surfaced: 12 kts
submerged: 25 kts
Diving depth: 350 m (1,150 ft).

Complement: 75 (10 officers); (SS 589) 71 (10 officers)

SUBMARINES

HARUSHIO (SS 583)
Builder Mitsubishi, Kobe, Japan
Laid down 21 Apr 1987
Launched 26 Jul 1989
Commissioned 30 Nov 1990

NATSUSHIO (SS 584)
Builder Kawasaki, Kobe, Japan
Laid down 8 Apr 1988
Launched 20 Mar 1990
Commissioned 20 Mar 1991

HAYASHIO (SS 585)
Builder Mitsubishi, Kobe, Japan
Laid down 9 Dec 1988
Launched 17 Jan 1991
Commissioned 25 Mar 1992

ARASHIO (SS 586)
Builder Kawasaki, Kobe, Japan
Laid down 8 Jan 1990
Launched 17 Mar 1992
Commissioned 17 Mar 1993

WAKASHIO (SS 587)
Builder Mitsubishi, Kobe, Japan
Laid down 12 Dec 1990
Launched 22 Jan 1993
Commissioned 1 Mar 1994

FUYUSHIO (SS 588)
Builder Kawasaki, Kobe, Japan
Laid down 12 Dec 1991
Launched 16 Feb 1994
Commissioned 7 Mar 1995

— (SS 589)
Builder Mitsubishi, Kobe, Japan
Laid down 24 Dec 1992
Launched Jun 1995
Commissioned Mar 1997

WEAPONS SYSTEMS

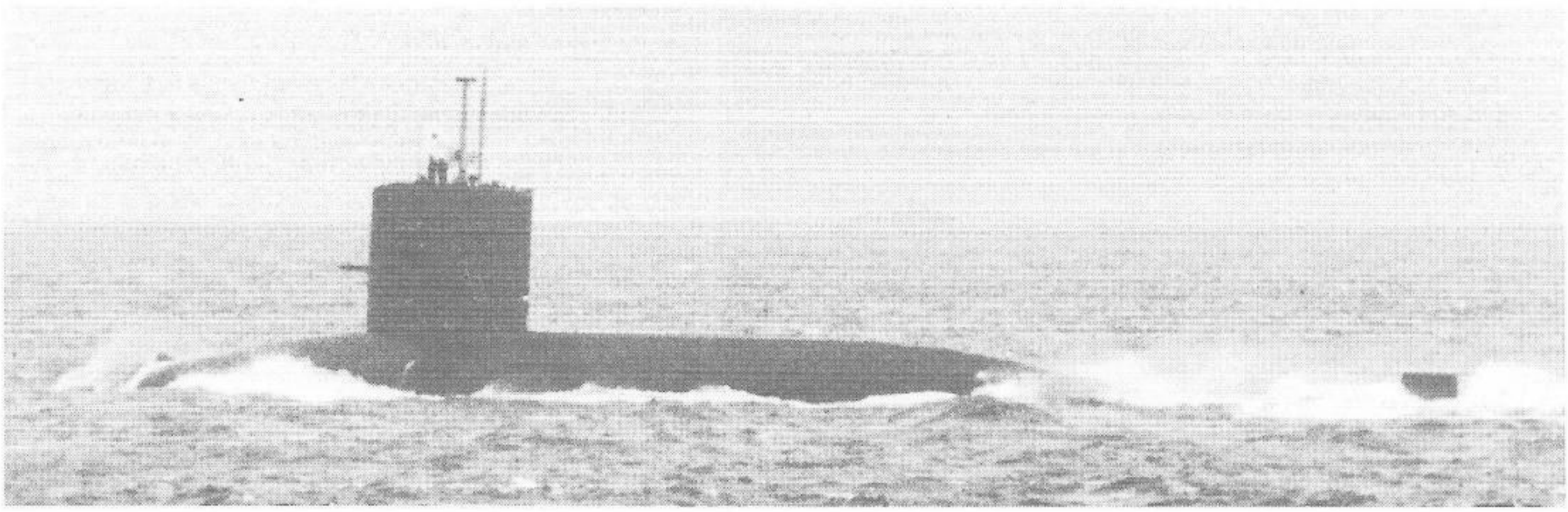
ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Sub-Harpoon

Sub-Harpoon arms all submarines in the class. Block 1C includes a number of options, including the ability to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses, or to approach the target indirectly, using up to three preselected waypoints. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 kg)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).



Harushio *(SS 583)* (H & L van Ginderen Collection)

TUBES

Six 533 mm (21 in) tubes; amidships.
Total weapon load, 20 torpedoes/Sub-Harpoon.

TORPEDOES

Type 89
Under the Medium-Term Defence Programme (FY86-90) the Type 89 has been developed as an equivalent to the US Mk 48 ADCAP weapon. It is powered by a thermal propulsion system giving it an exceptionally high speed in the region of 70 knots. Type 89 is wire-guided, uses active homing and has a range of about 30,000 m.

Specifications
Diameter: 533 mm (21 in)
Speed: 70 kts
Range: 30,000 m (32,820 yds)
Warhead: 267 kg (587.4 lb)
Max depth: 900 m (2,953 ft)
Performance: 27 n miles (50 km) at 40 kts; 21 n miles (38 km) at 55 kts

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

ZLR 3/5
ZLR-3/5 is a radar warning system, broadly equivalent to the US Navy's WLR-8. The latter covers the 50 MHz to 18 GHz band and provides automatic classification and identification of signals, and can trigger alarms against specified threats.

ZLR-4/6
ZLR-4/6 is a threat warning system broadly equivalent to the US Navy's WLR-1G.

COMMAND AND CONTROL SYSTEMS

RADAR

ZPS-6
The surface search radar is the I-band ZPS-6.

Manufacturer/Contractor
JRC Tokki, Japan.

SONARS

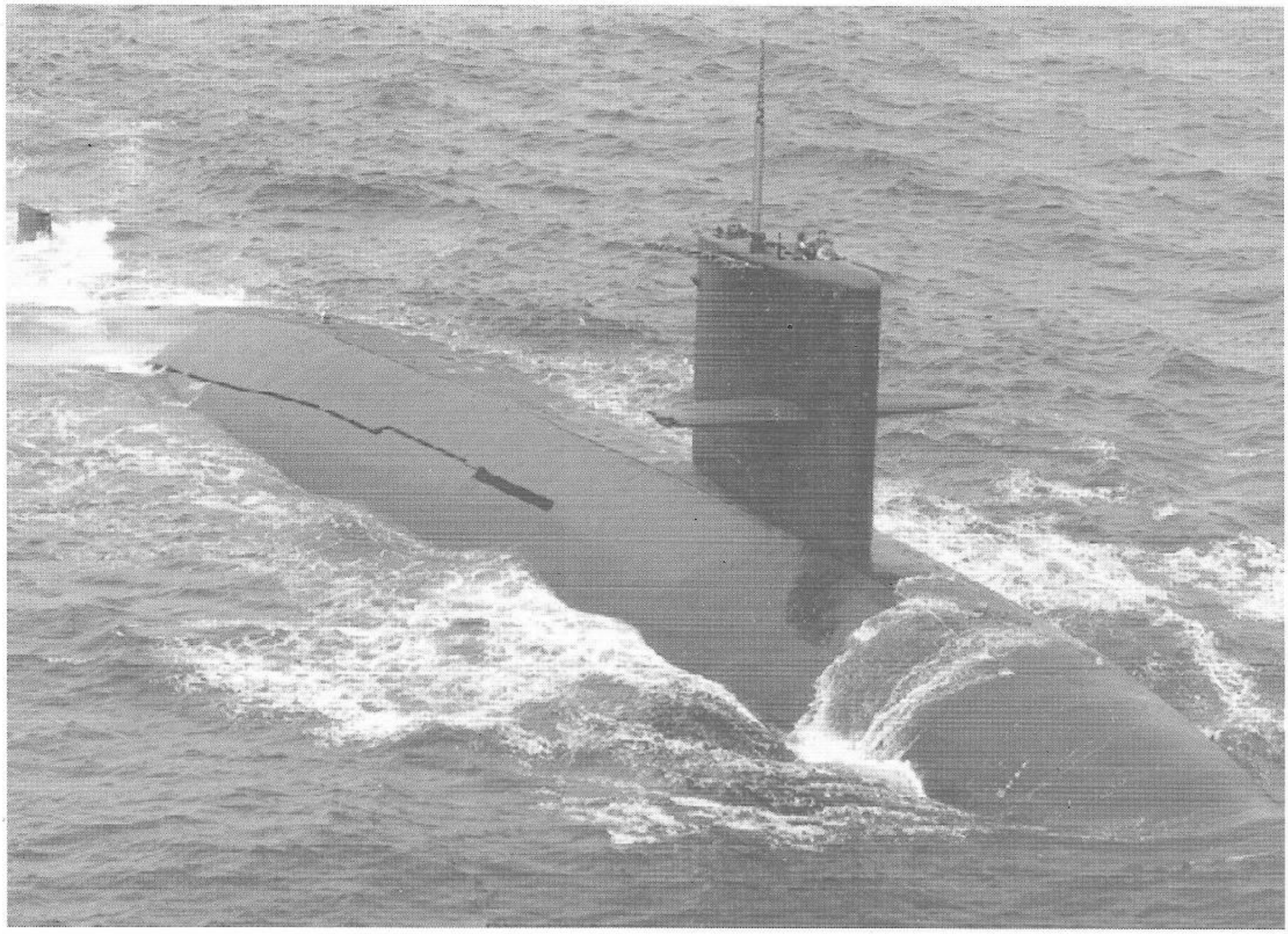
Hughes/Oki ZQQ-4, ZQQ-5, ZQR-1
The Hughes/Oki ZQQ-4 is a medium/low-frequency, bow-mounted spherical, passive/active search and attack sonar which originally equipped the 'Yuushio' class whose design is based on that of the US BQS-4. ZQQ-4 incorporates a clip-on towed linear passive intercept array, the ZQR-1, which is a very low-frequency, passive, towed array sonar similar to the US AN/BQR-15.

The latest sonar is the Hughes/Oki ZQQ-5B medium/low-frequency, active/passive search and attack sonar. This sonar suite equips the submarines of the 'Harushio' class 'as built' and is being retrofitted to the 'Yuushio' class. It incorporates a Japanese towed array which retracts into a housing running along the casing.

Manufacturer/Contractor
Hughes/Oki, Japan.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 Kawasaki 12V25/25S diesel generator sets; 4.1 MW (5,520 hp(m))
Alternators: 2 Kawasaki; 3.7 MW
Propulsion motors: 2 Fuji; 5.3 MW (7,200 hp(m))
Shaft: 1
Battery: 2 groups, each of 480 Yuasa cells



Harushio *(SS 583)* (JMSDF)

FURTHER INFORMATION

PROGRAMME

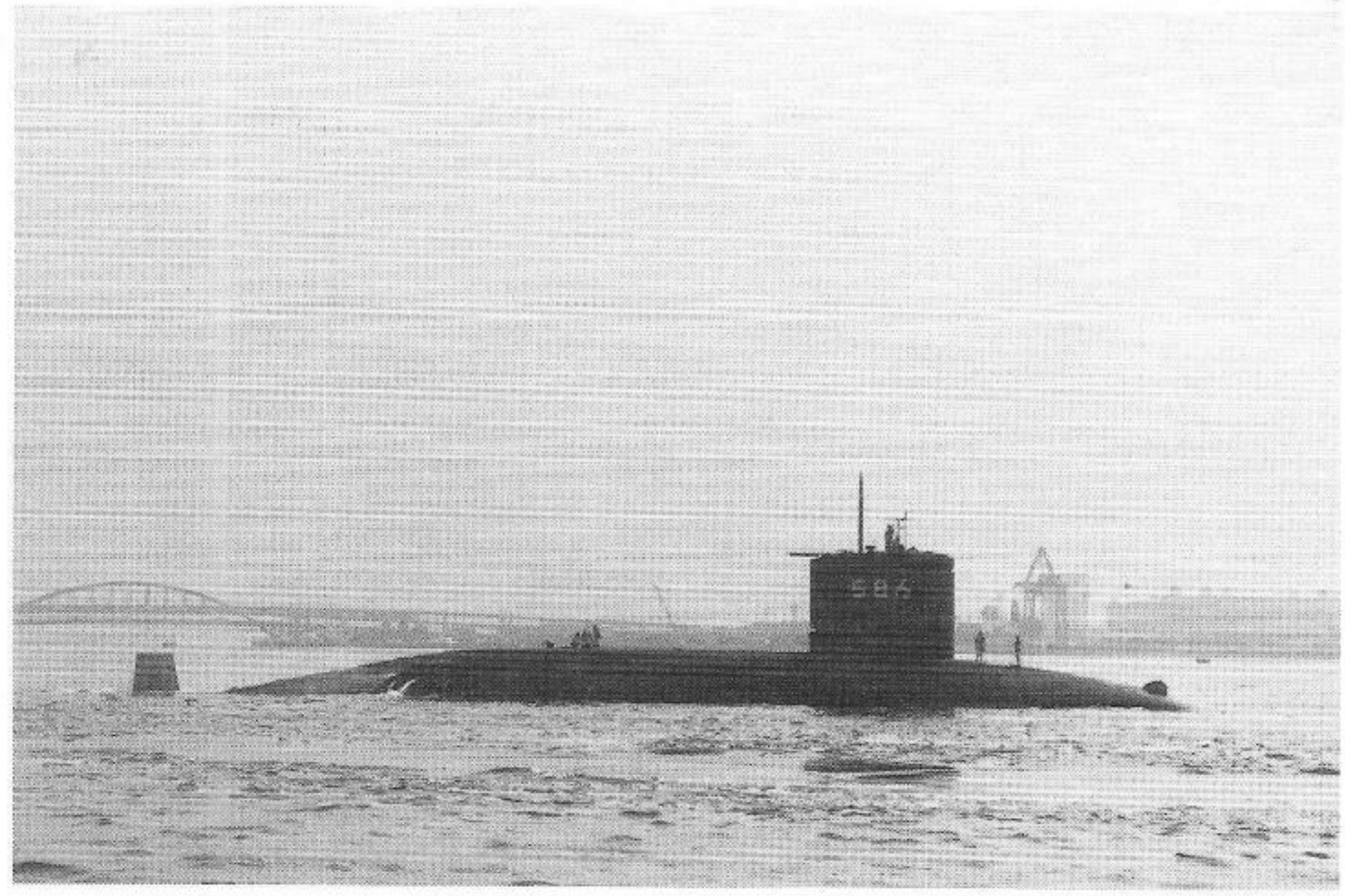
The first of class was approved in the FY86 estimates and one was laid down each year from 1987 to 1992, with entry into service in January 1990, and then annually in March until 1997.

DESIGN

The 'Harushio' class is essentially an enlarged and improved Yuushio and includes greater noise reduction, towed sonar, towed VLF radio antenna, and, for the first time in Japanese submarines, anechoic coatings. The pressure hull is constructed of NS 100 steel, with a yield of 110 kg/mm² which gives a significant increase in diving depth compared with the 'Yuushio' class.

SS 589

The last of this class, SS 589, includes a number of modifications. It has a slightly greater displacement, an increased automation resulting in a slightly reduced crew, and may also incorporate a Kockums Sterling AIP engine, of the type which has been under test in Japan for some years.



Arashio *(SS 586)* (Hachiro Nakai)

IMPROVED HARUSHIO

GENERAL SPECIFICATIONS

Country: Japan

Class: IMPROVED HARUSHIO

Building: 2
In service: 0
Proposed: 1

Displacement:
surfaced: 2,700 t
submerged: 3,000 t

Speed:
surfaced: 12 kts
submerged: 24 kts

Complement: 69 (10 officers)

SUBMARINES

— (SS 590)

Builder	Kawasaki, Kobe, Japan
Laid down	26 Jan 1994
Launched	Nov 1996
Commissioned	Mar 1998

— (SS 591)

Builder	Mitsubishi, Kobe, Japan
Laid down	1995
Launched	1997
Commissioned	1999

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 2 Kawasaki 12V25 diesels; 4.1 MW (5,520 hp(m))

Alternators: 2 Kawasaki alternators; 3.7 MW
Electric motors: 2 Fuji motors; 5.3 MW (7,200 hp(m))
Shafts: 1 shaft

FURTHER INFORMATION

PROGRAMME

The first of this new class was approved in the 1993 budget, followed by authorisation for the second in FY94 and the third in FY95. The building may, however, be delayed by the damage caused by the earthquake in Kobe, Japan in January 1995.

DESIGN

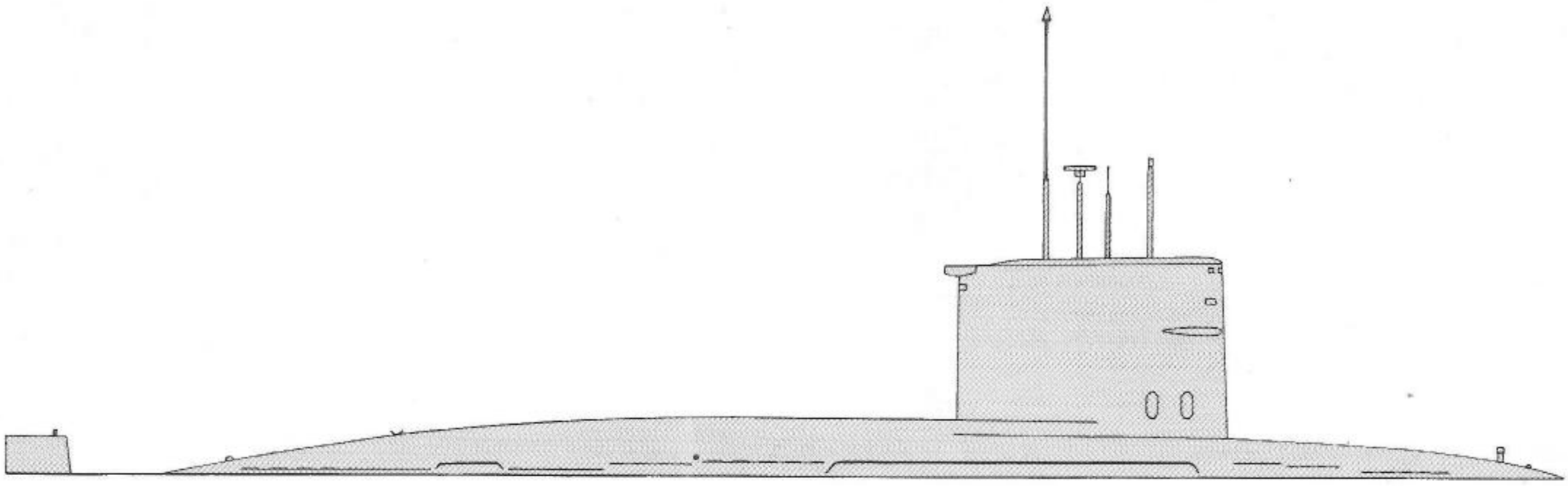
These boats are to be fitted with large flank sonar arrays which are reported as the reason for the increase in displacement over the 'Harushio' class.

PROPULSION

Kawasaki Heavy Industries has carried out a series of experiments with alternative power sources, which have included a 75 kW Stirling engine purchased from Swedish company, Kockums; fuel cells and, on a commercial basis, a magneto-hydrodynamic (MHD) propulsion system. The government's Technical Research and Development Institute has also conducted tests on the Stirling engine.

An AIP system should be ready in time for the first of the 'Improved Harushio' class although if it is not, it will definitely be ready for the next class after that.

ZWAARDVIS



Zwaardvis (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Netherlands

Class: ZWAARDVIS

Built: 2
Awaiting sale: 2

Displacement:
surfaced: 2,350 t
submerged: 2,640 t

Dimensions
Length: 66 m (216.5 ft)
Beam: 8.4 m (27.6 ft)
Draught: 7.1 m (23.3 ft)

Speed:
surfaced: 13 kts
submerged: 20 kts
Diving depth: 200 m (656 ft)
Range, snorting: 10,000 n miles at 9 kts

Complement: 67 (8 officers)

SUBMARINES

ZWAARDVIS (S 806)

Builder	Rotterdamse Droogdok Mij, Rotterdam, Netherlands
Laid down	14 Jul 1966
Launched	2 Jul 1970
Commissioned	18 Aug 1972

TIJGERHAAI (S 807)

Builder	Rotterdamse Droogdok Mij, Rotterdam, Netherlands
Laid down	14 Jul 1966
Launched	25 May 1971
Commissioned	20 Oct 1972

WEAPONS SYSTEMS

(See 'Further Information')

ANTI-SHIP MISSILES

McDonnell Douglas Sub-Harpoon
The two 'Zwaardvis' class boats were fitted for, but not with, Sub-Harpoon.

TUBES

Six 21 in (533 mm) bow tubes.
Total weapons load, 20.

TORPEDOES

The tubes could be adapted to launch the type of torpedo used by the purchaser.

ELECTRONIC WARFARE SYSTEMS

(See 'Further Information')

ELECTRONIC SUPPORT MEASURES (ESM)

ARGOSystemS AR 700.

COMMAND AND CONTROL SYSTEMS

(See 'Further Information')

WEAPONS CONTROL

Signaal M8 digital system.

RADAR

RN Type 1001 surface search; I band.

SONARS

Thomson Sintra Eledone.
GEC Avionics Type 2026.

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 3 Werkspoor RUB 215X12 diesels; 3.1 MW (4,200 hp(m))

Electric motor: 1 motor; 3.75 MW (5,100 hp(m))
Shaft: 1 shaft
Batteries: 3 groups, each of 140 cells

FURTHER INFORMATION

PROGRAMMES

In the 1964 Dutch Navy Estimates a first instalment was approved for the construction of two conventionally powered submarines of tear-drop design. They were originally intended to serve in the RNethN until 2000, but post-Cold War economies led to their retirement in 1996.

DESIGN

The design of this class was based on that of USS *Barbel,* the last diesel-electric submarine to be built for the US Navy. The design was, however, amended to enable Dutch electronic and mechanical equipment to be installed.

MODERNISATION

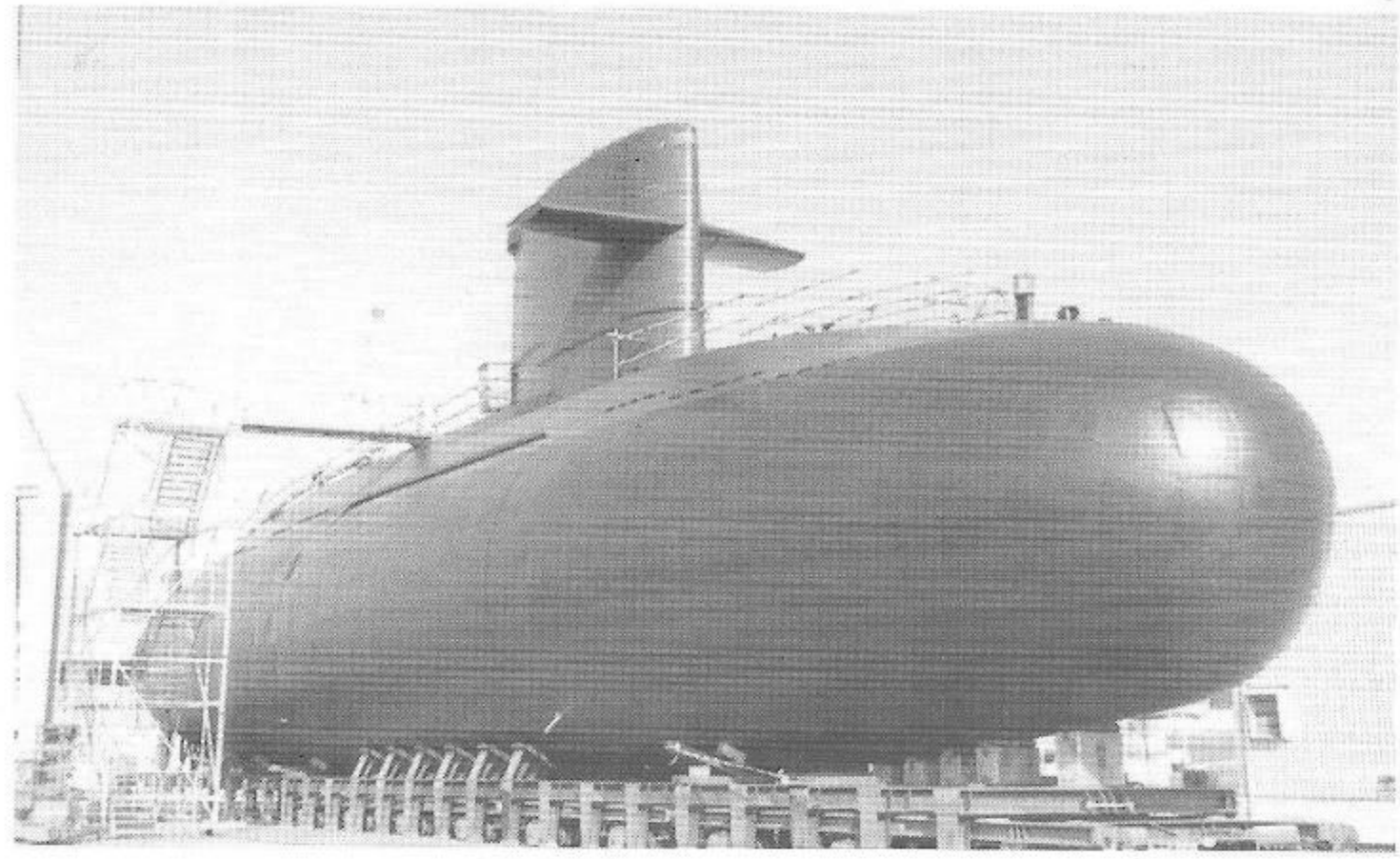
Both boats underwent mid-life conversion while in Dutch service: *Tijgerhaai* in 1988 and *Zwaardvis* in 1989-91. This included fitting new Thomson Sintra Eledone sonar, Signaal fire control and GEC Avionics Type 2026 towed array, as well as other minor improvements including a quieter propulsion drive unit and shaft.

SALE

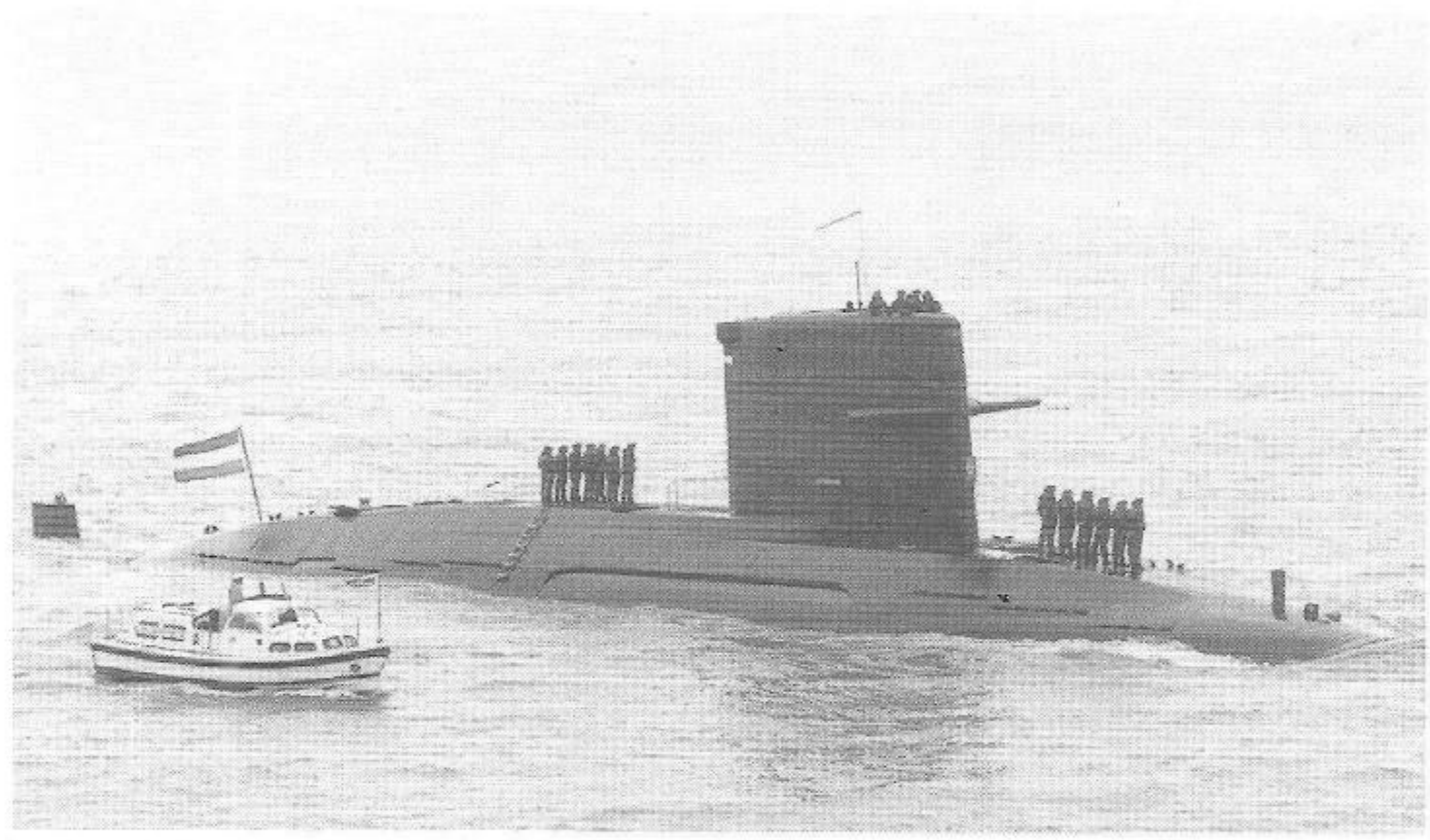
These two submarines are now laid up at RDM, available for sale at a price reported to be in the region of $45 million each. It is reported that among countries interested are Indonesia, to whom the Netherlands has previously supplied much naval equipment, and Taiwan, which already operates the two 'Hai Lung' (modified Zwaardvis) class boats. A sales deal might include not only the two 'Zwaardvis' class boats, but also one or more new-build 'Moray' class submarines, which RDM and the British company VSEL are marketing.

Note

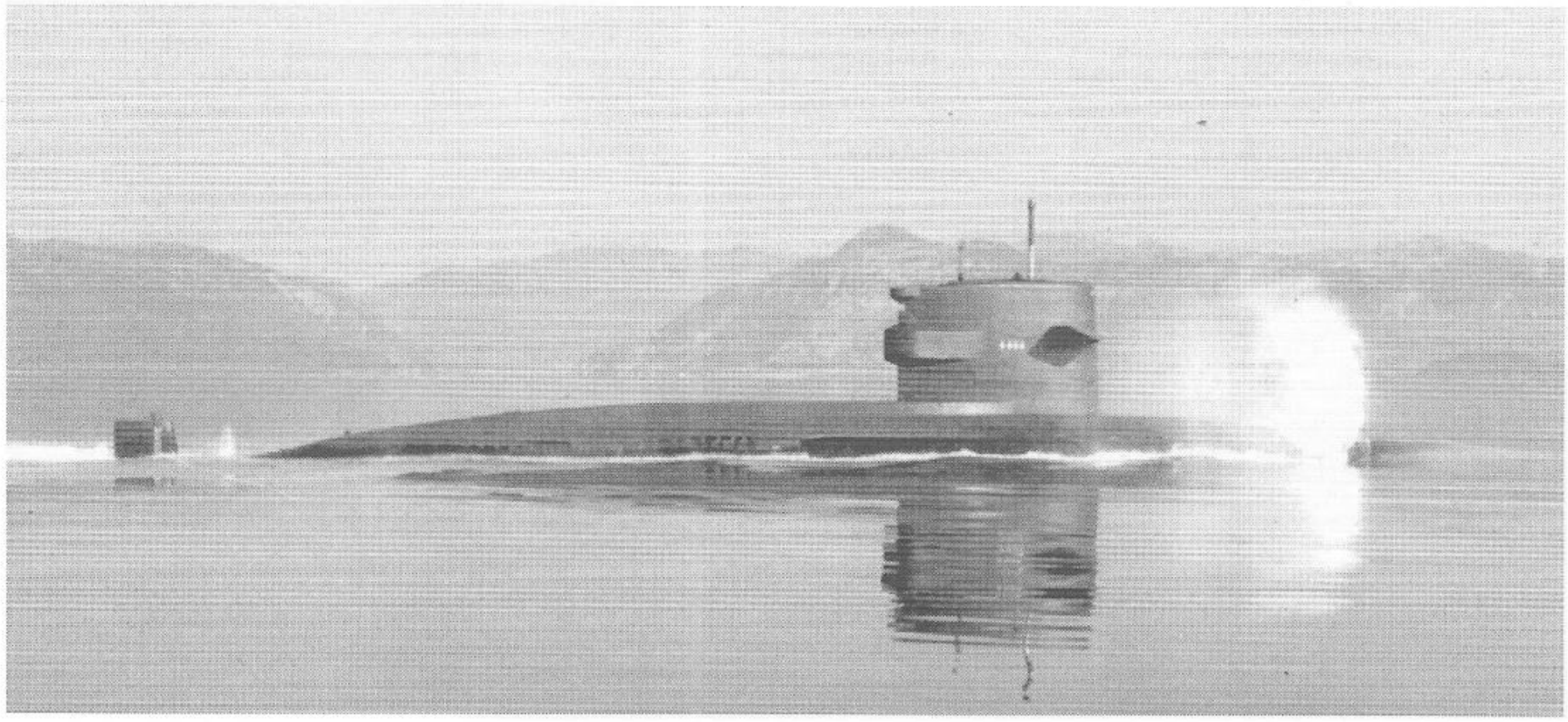
No details of weapons and electronic systems are given, since a new purchaser would almost certainly require most to be replaced, while some might not be released to a non-NATO operator. The list represents the equipment and capabilities of the two submarines at the time they were decommissioned.



Zwaardvis *(S 806) high-and-dry in August 1995, awaiting a purchaser* (H & L van Ginderen Collection)

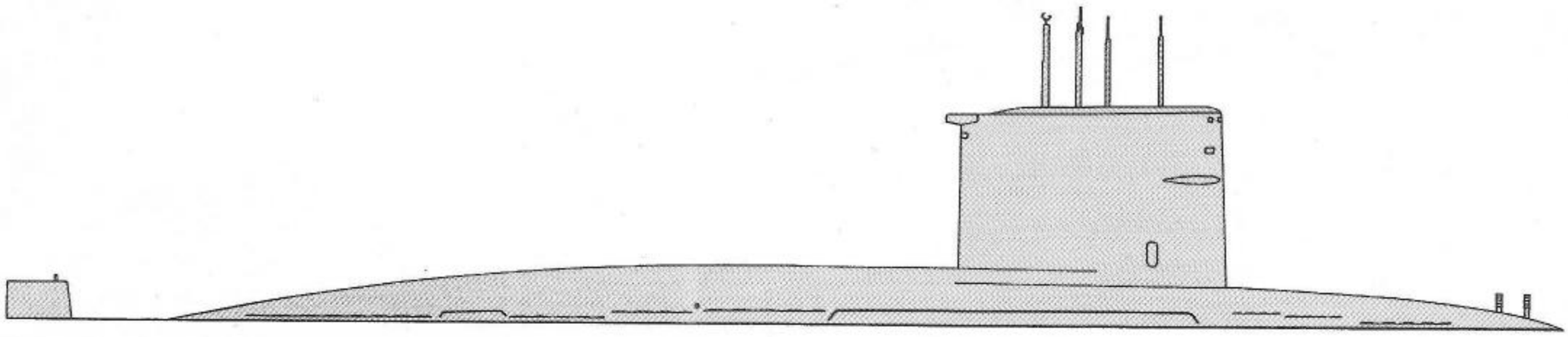


Tijgerhaai *(S 807) in 1991. The design of this class was based on that of USS* Barbel (H & L van Ginderen Collection)



Zwaardvis *(S 806) submerging off the Norweigan coast* (RDM)

HAI LUNG (MODIFIED ZWAARDVIS)



Hai Lung (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Taiwan (Republic of China)

Class: HAI LUNG
Type: Modified Zwaardvis

Bought: 2
In service: 2

Displacement:
surfaced: 2,376 t
submerged: 2,660 t

Dimensions
Length: 66.9 m (219.6 ft)
Beam: 8.4 m (27.6 ft)
Draught: 6.7 m (22.0 ft)

Speed:
surfaced: 12 kts
submerged: 20 kts
Range, surfaced: 10,000 n miles at 9 kts

Complement: 67 (8 officers)

SUBMARINES

HAI LUNG (793)

Builder	Wilton Fijenoord, Netherlands
Laid down	1982
Launched	6 Oct 1986
Commissioned	9 Oct 1987

HAI HU (794)

Builder	Wilton Fijenoord, Netherlands
Laid down	1982
Launched	20 Dec 1986
Commissioned	9 Apr 1988

WEAPONS SYSTEMS

TUBES

Six 533 mm (21 in); bow.
Total weapon load, 20.

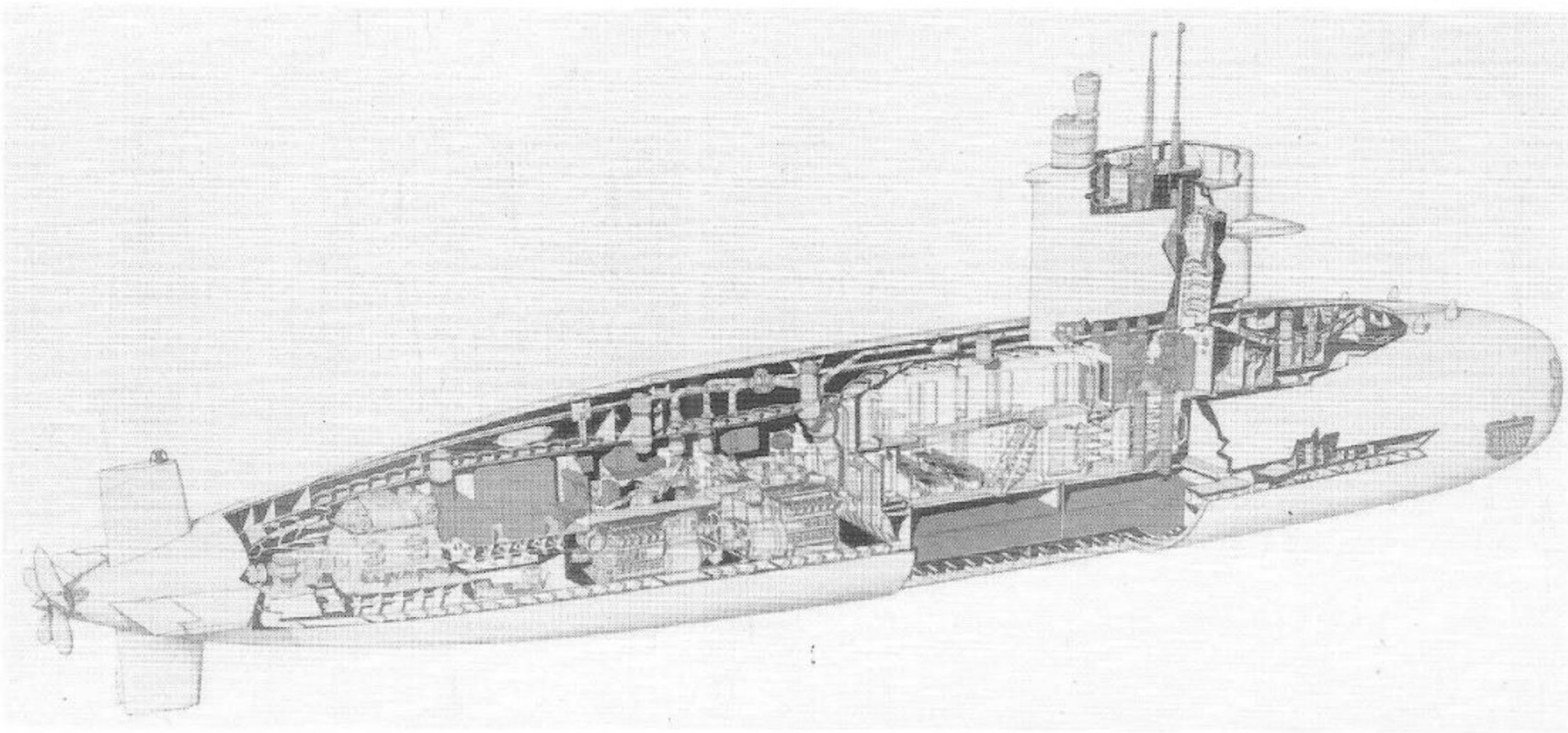
TORPEDOES

STN Atlas AEG SUT

The RoC Navy has apparently managed to obtain its torpedoes from Indonesia, where the STN Atlas SUT is produced under licence. The SUT (Surface and Underwater Target) is a dual-purpose, wire-guided torpedo for engaging both surface and submarine targets. Its electrical propulsion permits variable speed in accordance with tactical requirements, silent running and wakelessness. The wire guidance gives immunity to interference with a two-way datalink between vessel and torpedo. The acoustic homing head has long acquisition ranges and a wide search sector for active and passive operation. After termination of guidance wire, SUT continues operation as a highly intelligent homing torpedo, with internal guidance programmes for target search, target loss and so on. The large payload with combined fuze systems ensures the optimum effect of explosive power. The SUT operates at great depths as well as in very shallow waters. Consort operation permits exploitation of the full over-the-horizon range of the SUT.

Specifications
Length: 6.15 m (20.18 ft)
Diameter: 533 mm (21 in)
Weight: 1,420 kg (3,130 lb)
Warhead: 260 kg (573.2 lb)
Homing: Active/passive
Performance: 6.6 n miles (12 km) at 35 kts
Fuze: Magnetic, proximity and impact

Manufacturer/Contractor
Manufactured in Indonesia under licence from STN Atlas Elektronik GmbH, Bremen, Germany.



Cutaway of 'Hai Lung' class (Wilton-Fijenoord B.V.)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Signaal RAPIDS

RAPIDS (RAdar Passive Idenitification System) is a radar warning device covering four bands: 2-4 GHz, 4-8 GHz' 8-12 GHz and 12-18 GHz.

Manufacturer/Contractor

Hollandse Signaalapparaten BV, Hengelo, Netherlands.

COMMAND AND CONTROL SYSTEMS

RADAR

Signaal ZW 06

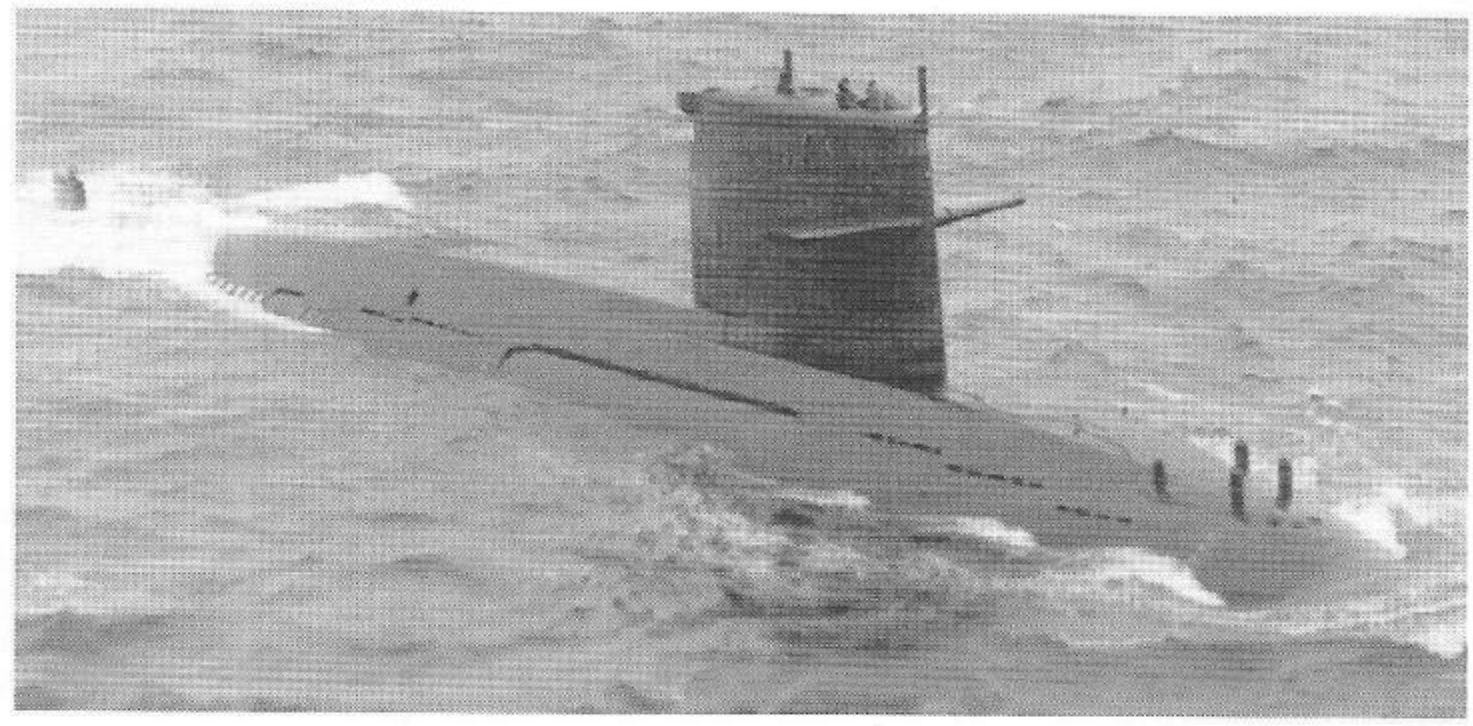
The ZW 06 is a surface search and navigation radar, with limited air search facilities.

Specifications

Frequency: I-band
Polarisation: Linear and circular, selectable
Transmitter: Tunable magnetron
Power output: 60 kW peak; 60 W average
Max range: 22 km against small surface craft

Manufacturer/Contractor

Hollandse Signaalapparaten BV, Hengelo, Netherlands.



Hai Lung *(Sea Dragon). The four objects on the forward casing are part of a Signaal sonar system* (Signaal)

SONARS

Signaal SPECTRUM I/SIASS integrated sonar and fire-control system

Signaal developed its SINBADS (Submarine INtegrated Battle And Data System) system throughout the 1970s to become an integrated submarine sonar-combat system. The outcome was the Spectrum I system, which was sold to Taiwan for deployment in the two 'Hai Lung' class submarines.

SINBADS is an integrated command and weapon control system based upon a federated architecture. Spectrum I not only has the SINBADS system, but, in addition, has Signaal SIASS (Submarine Integrated Attack and Surveillance Sonar) system added, which increases the processor requirements which are met by 10 SMR-MU computers supplemented by 24 microprocessors. The SPECTRUM I system can simultaneously control four torpedoes and four missiles.

SPECTRUM is divided into four subsystems; sonar suite, display system, a common processor and independent weapon electronics units. A radar, an ESM system and communications systems are integral elements of SPECTRUM.

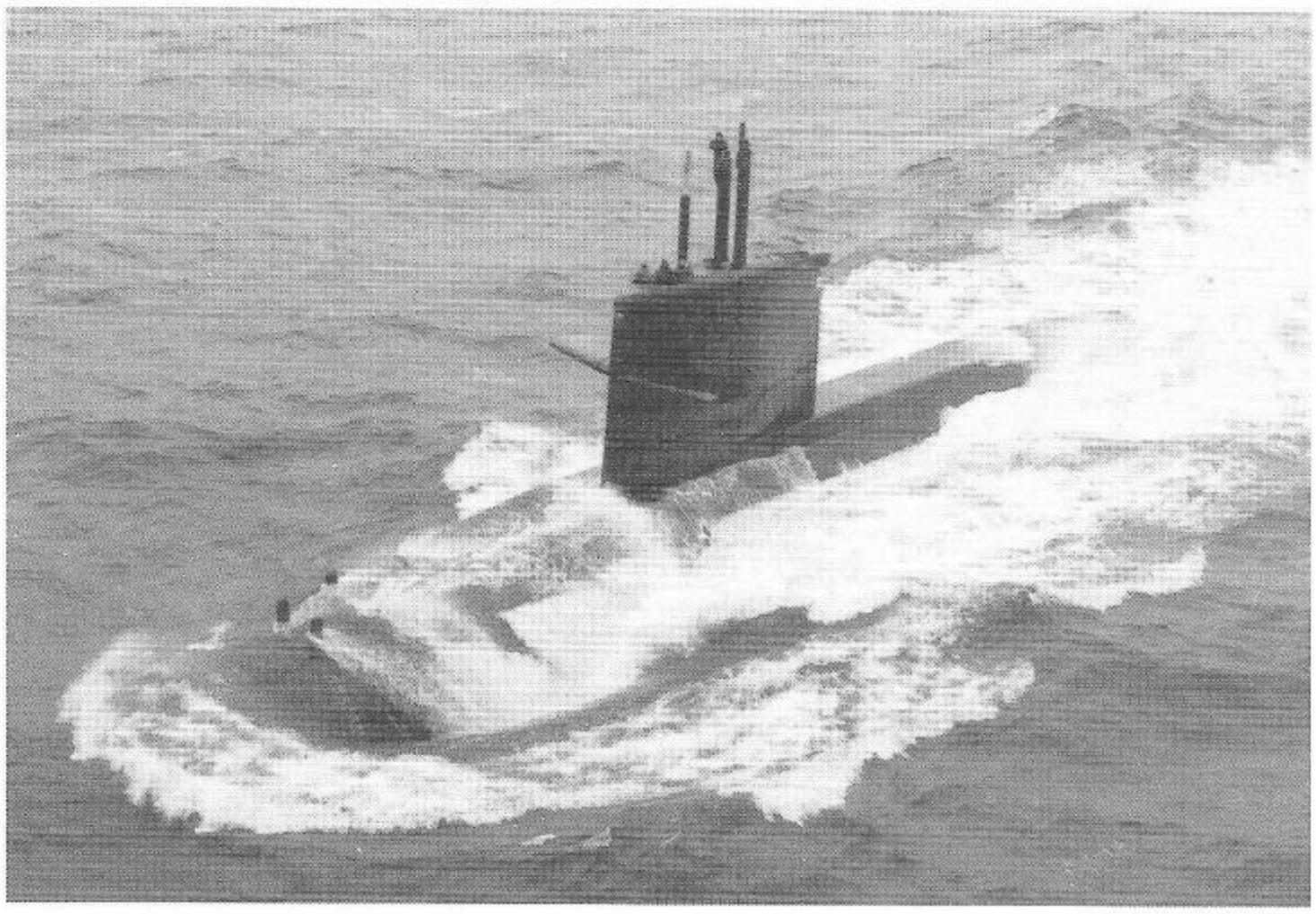
The SIASS sonar suite consists of a bow-mounted cylindrical array, a flank array sonar, a passive ranging sonar and an intercept sonar. The cylindrical array, which is the prime attack sensor, operates in narrow and medium frequencies in the broadbands and has its own processing cabinet. The system, which produces 96 preformed beams also has low-frequency passive acoustic intercept as well as directional or omnidirectional active capabilities.

The flank arrays use 24 acceleration cancelling type hydrophones which operate in narrowband and in low frequencies in the broadband. The system, which has its own processing cabinet, produces 64 beams covering large bearing sectors on each side of the boat and is for long-range detection and tracking. It may also be used as the primary attack sensor within its frequency range.

The passive ranging sonar, which is usually slaved to the cylindrical array, consists of three arrays on either side of the boat and uses a method of frequency-domain correlation to measure wavefront curvature. Acoustic clutter is removed and the signal-to-noise ratio is increased by using variable tracking bandwidths. This system shares a processing cabinet with the four-transducer high-frequency (90-100 kHz) intercept sonar, which uses FFT techniques to detect, correlate and classify torpedo or sonar intercepts and provides automatic alarms for a number of preset threats. Both also have enhanced classification channels; zoom LOFAR for high-resolution vernier analysis and DEMON (DE-MOdulated Noise) to measure frequencies below 100 Hz by analysing cavitation and flow noise in higher bands, then demodulating the results. This is used to indicate target parameters such as the number of propeller blades and shaft rotation speeds.

SIASS can store 35 tracks and can perform TMA on up to 20 tracks. Each sonar has a library on up to 300 specific platforms including 100 ship classes and 100 sonar types. The greater sophistication of the system generates a requirement for more DaCCs, usually four or five. A TV display may be added to show pictures from optical or electro-optical sensors within the periscope.

It should be noted that these two submarines are fitted for, but not with, a towed array.



Hai Hu (Sea Tiger) (Wilton-Fijenoord B.V.)

Manufacturer/Contractor

Hollandse Signaalapparaten BV, Hengelo, Netherlands.

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 3 Bronswerk D-RUB 215-12 diesels; 3 MW (4,050 hp(m))
Alternators: 3 alternators; 2.7 MW
Electric motor: 1 Holec motor; 3.74 MW (5,100 hp(m))
Shaft: 1 shaft
Battery: 2 groups, each of 196 cells

FURTHER INFORMATION

PROGRAMME

The strenuous efforts by the RoC Navy to establish a force of modern submarines for ASW operations to counter the threat posed by the large PRC underwater force, has been actively, and for the most part, very successfully, obstructed by Beijing. The only success achieved by the RoC has been the delivery of these two Dutch-built submarines.

The order for these submarines was signed with Wilton Fijenoord in September 1981 amidst strong protests from the PRC Government, although these were resisted by the Dutch Government. Construction was delayed by the financial difficulties of the builders, but was resumed in 1983. Sea trials of *Hai Lung* took place in March 1987 and of *Hai Hu* in January 1988 and they were shipped out on board heavy dock vessels in October 1987 and June 1988, respectively.

DESIGN

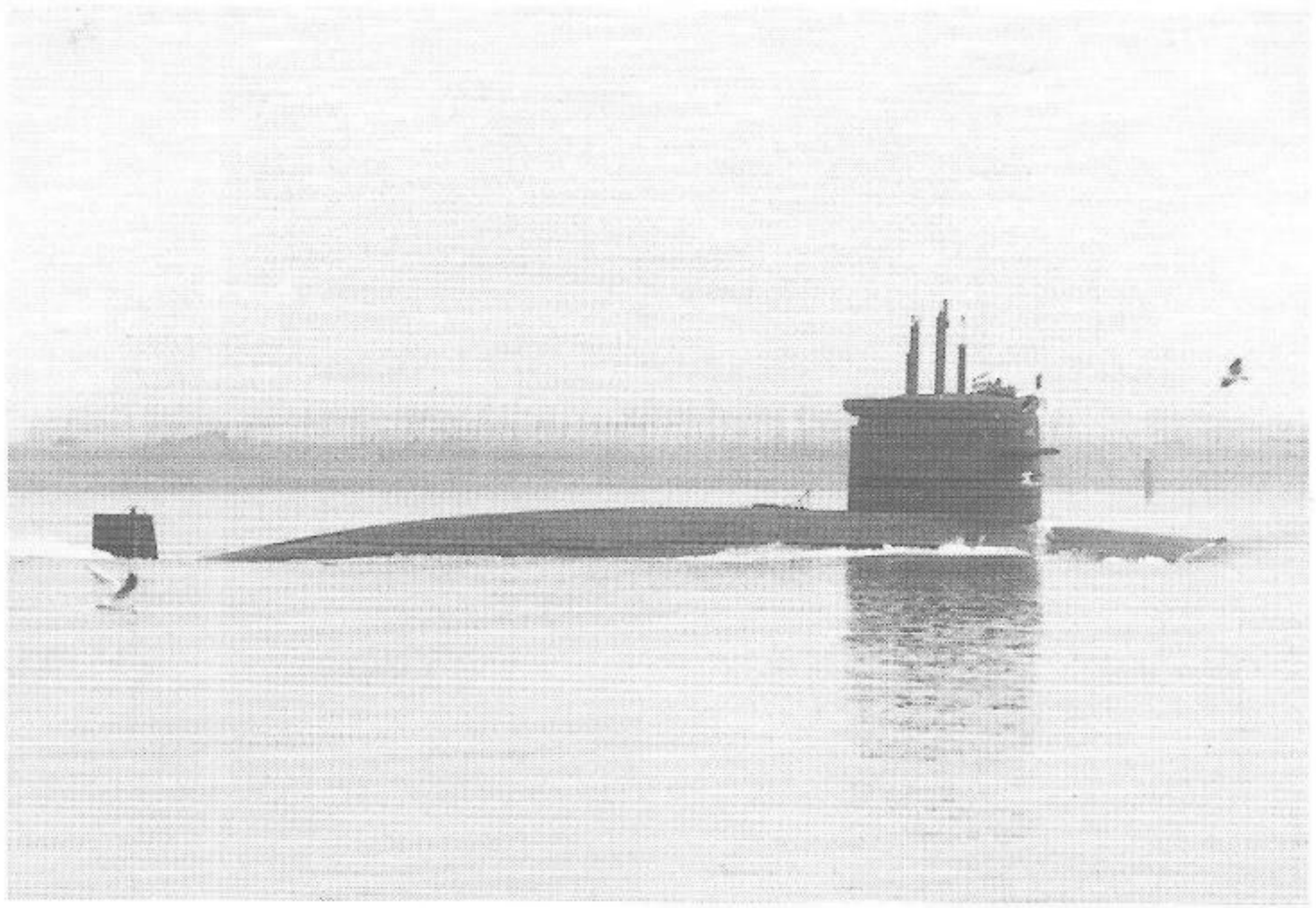
These submarines are basically the Dutch Zwaardvis design, but with minor variations to suit the RoC Navy's needs. The four horns on the forward casing are Signaal sonar intercept transducers. The torpedoes are manufactured under licence in Indonesia.

NAMES

The names mean Sea Dragon and Sea Tiger, respectively.

OPERATIONAL

Since efforts by the PRC have prevented the RoC Navy from obtaining modern submarine-launched missiles such as Sub-Harpoon or Exocet, the Taiwanese have been forced to develop their own. It is, therefore, planned that these submarines will be armed with Hsiung Feng 2 submerged launch SSMs, but a torpedo tube-launched version is still being developed.



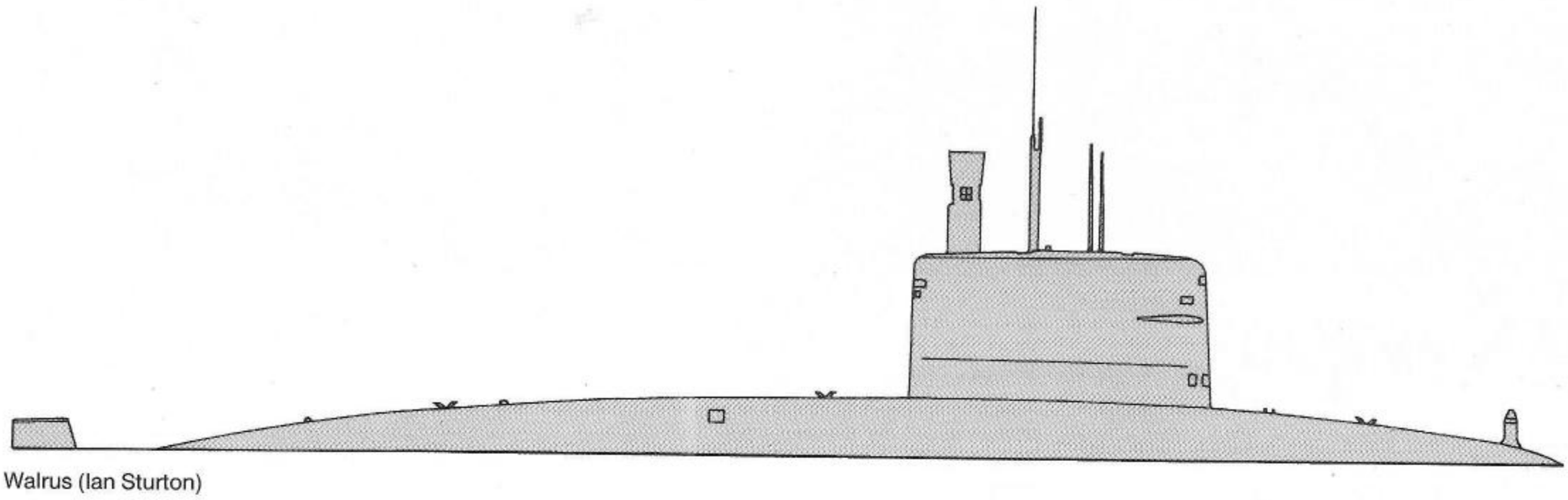
Hai Hu (H & L van Ginderen Collection)

THE FUTURE

The RoC Government tried very hard to place an order for two more of this class from the Netherlands, with an option on a further two after that. The Dutch Government, which had stood firm over the order for the first two, felt unable to sanction these further orders.

The RoC Navy has tried almost everywhere in the world where it might obtain further submarines, either as new-builds or as old, surplus vessels which could then be modernised in Taiwanese yards. So far, this has been without success, although there are reports that the RoC is now concentrating its efforts on obtaining the two redundant Dutch Zwaardvis boats, either directly from RDM or, perhaps, through a third party.

WALRUS



Walrus (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Netherlands

Class: WALRUS

Built: 4
In service: 4

Displacement:
surfaced: 2,465 t
submerged: 2,800 t

Dimensions
Length: 67.7 m (222.1 ft)
Beam: 8.4 m (27.56 ft)
Draught: 7 m (22.96 ft)

Speed:
surfaced: 12 kts
submerged: 20 kts
Diving depth: 300 m (984 ft)
Range, snorting: 10,000 n miles at 9 kts

Complement: 52 (7 officers)

SUBMARINES

WALRUS (S 802)
Builder Rotterdamse Droogdok Mij, Rotterdam, Netherlands
Laid down 11 Oct 1979
Launched 26 Oct 1985 (13 Sep 1989)
Commissioned 25 Mar 1992

ZEELEEUW (S 803)
Builder Rotterdamse Droogdok Mij, Rotterdam, Netherlands
Laid down 24 Sep 1981
Launched 20 Jun 1987
Commissioned 25 Apr 1990

DOLFIJN (S 808)
Builder Rotterdamse Droogdok Mij, Rotterdam, Netherlands
Laid down 12 Jun 1986
Launched 25 Apr 1990
Commissioned 29 Jan 1993

BRUINVIS (S 810)
Builder Rotterdamse Droogdok Mij, Rotterdam, Netherlands
Laid down 14 Apr 1988
Launched 25 Apr 1992
Commissioned 5 Jul 1994

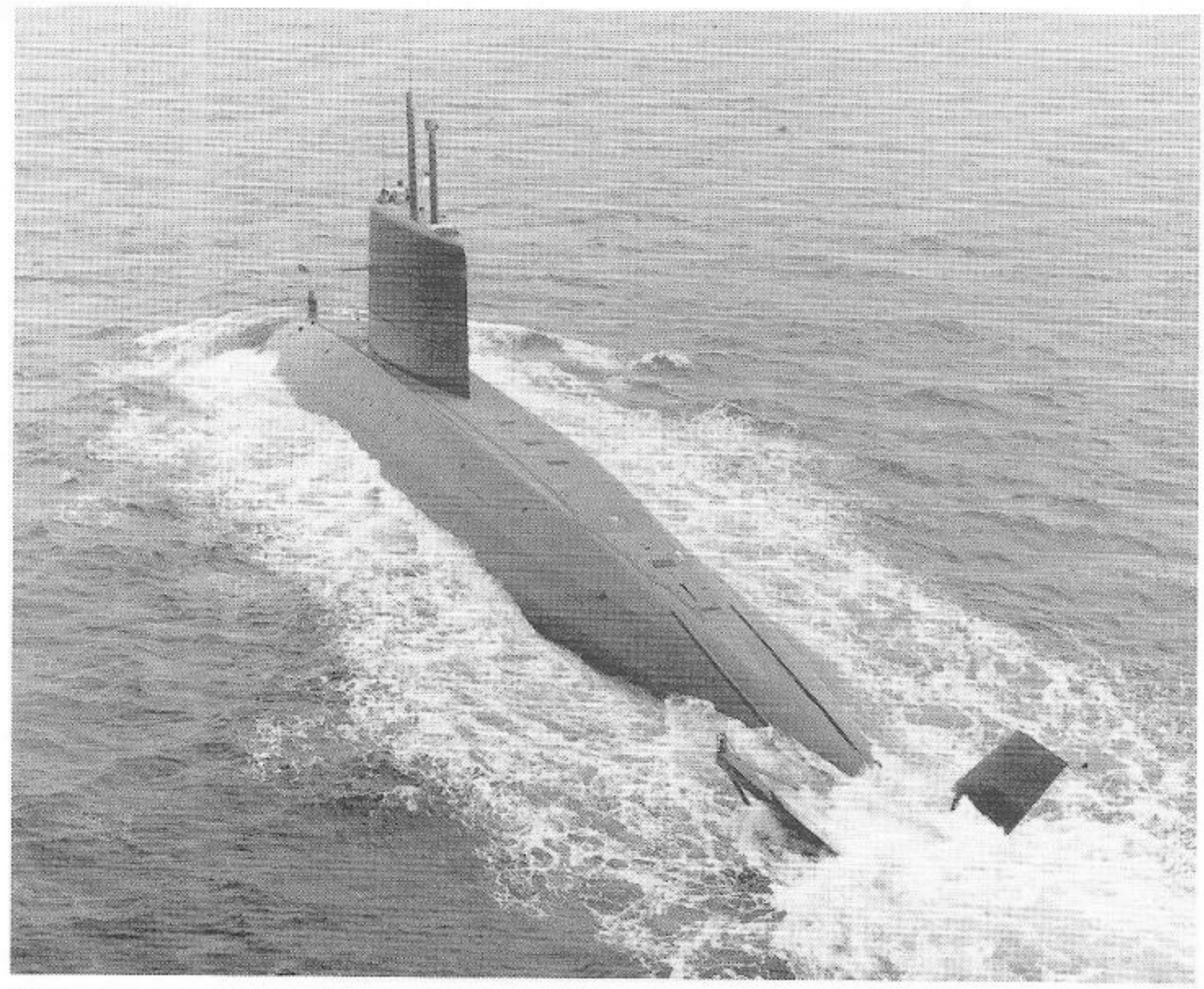
WEAPONS SYSTEMS

ANTI-SHIP MISSILES

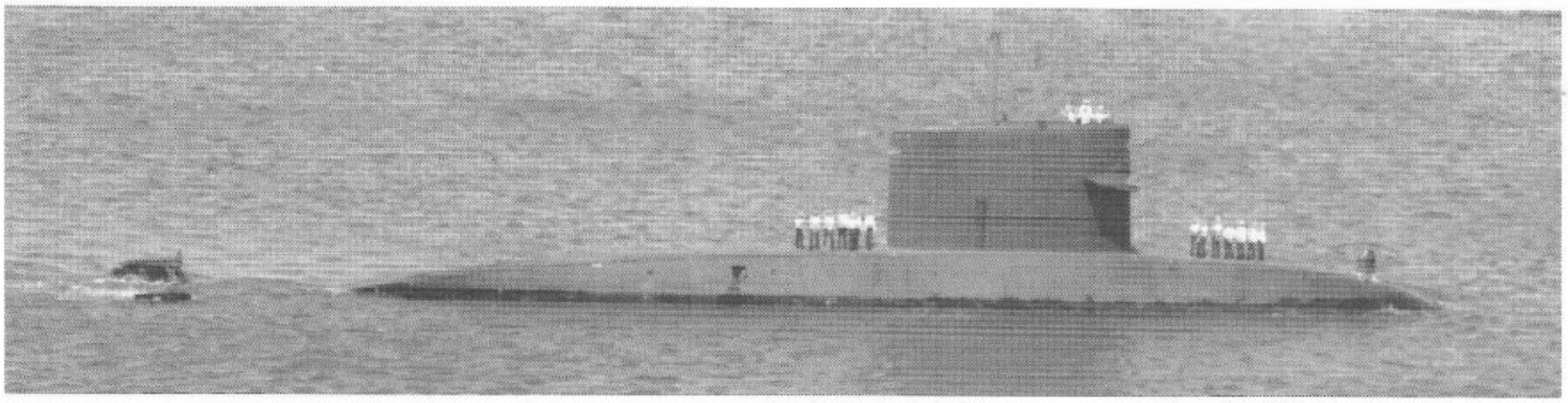
McDonnell Douglas UGM-84B Sub-Harpoon

Sub-Harpoon arms all submarines in the class. Block 1C includes a number of options, including the ability to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses, or to approach the target indirectly, using up to three preselected waypoints. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar



'Walrus' class submarine. The smooth finish on the hull is very noticeable (Netherlands Navy)



Zeeleeuw *(S 803)* (H & L van Ginderen Collection)

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).

US Naval Weapons Center, China Lake, California, USA (warhead).

Thiokol, Elkton, Maryland, USA (booster).

TUBES

Four 533 mm (21 in) tubes; Mk 19 Turbine ejection pump. Mk 67 water-ram discharge.

Total weapon load, 20 torpedoes/missiles.

TORPEDOES

Mk 48 Mod 4

The Mk 48 torpedo is an anti-submarine and anti-ship weapon, capable of operating in wire-guided, acoustic and non-acoustic modes, with the acoustic modes being either active or passive. Externally the Mk 48 is a long slim cylinder with a flat nose and four fin-like wire dispensers faired into the after body ahead of the shrouded, axial flow, pump-jet propulsor. The wire link is two-way, enabling data from the weapon's homing and guidance system to be relayed to the submarine fire-control system, so that the weapon can be guided more accurately from the submarine.

Specifications

Length: 5.84 m (19.16 ft)

Diameter: 533 mm (21 in)

Weight: 633 kg (1,395 lb)

Range: 21 n miles (38 km) at 55 kts or 27 n miles (50 km) at 40 kts

Max depth: 760 m (2,490 ft)

Max speed: 55 kts

Warhead: 267 kg (589 lb)

Manufacturers/Contractors

Hughes Aircraft Company, Ground Systems Group (prime).

Westinghouse Electric Corporation (second source).

Alliant NT 37

The NT 37 is a dual-purpose 485 mm (19 in) diameter ASW and anti-ship torpedo and is a total redesign of the original US Navy Mk 37 torpedo, the only original element common to both being the torpedo hull. All the internal subsystems, including propulsion, sonar and guidance, have been completely replaced by new hardware and software. Compared to previous models, the new Otto-fuelled, thermochemical propulsion system gives a 40 per cent increase in speed, a 150 per cent increase in range, and an 80 per cent increase in endurance. A solid-state acoustic system and a noise-reduction, laminar flow nose assembly replace the Mk 37's vacuum-tube acoustic panel and hemispherical nose. A new sonar substantially improves passive detection range against high-speed surface targets and active detection range against small silhouette submarine targets; in most cases, target acquisition range has been doubled. The new self-noise reduction nose assembly increases transducer isolation while reducing flow noise effects, thus reducing the likelihood of self-decoying at all depths.

Specifications

NT 37

Guidance: Wire-guided

Length: 4.505 m (14.78 ft)

Diameter: 485 mm (fits 533 mm launch tubes)

Weight: 750 kg (1,653 lb)

Range: 10.8 n miles (20 km) at 35 kts

Run modes: Straight run/salvo anti-ship; straight run with acoustic miss indicator to initiate acoustic re-attack; active snake and circle — ASW; passive snake and circle — anti-ship

Warhead: 150 kg HE (331 lb)

Fuze: Contact and proximity

Propulsion: Thermochemical rotary piston cam engine with Otto fuel

Manufacturer/Contractor

Alliant Techsystems, Marine Systems, Hopkins, Minnesota, USA.

MINES

40 mines can be carried in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

ARGOSystems AR-700(V)

The ARGOSystems AR-700A(V) is an ESM/DF system covering the 0.5 to 18 GHz frequency band, using the ASP-2000 signal processor. It uses a small periscope-mounted, omnidirectional antenna, providing instantaneous DF accuracy of 5° RMS, together with an ESM antenna with 2° RMS accuracy for over-the-horizon targeting.

Manufacturer/Contractor

ARGOSystems, Sunnyvale, California, USA.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Signaal SEWACO VIII

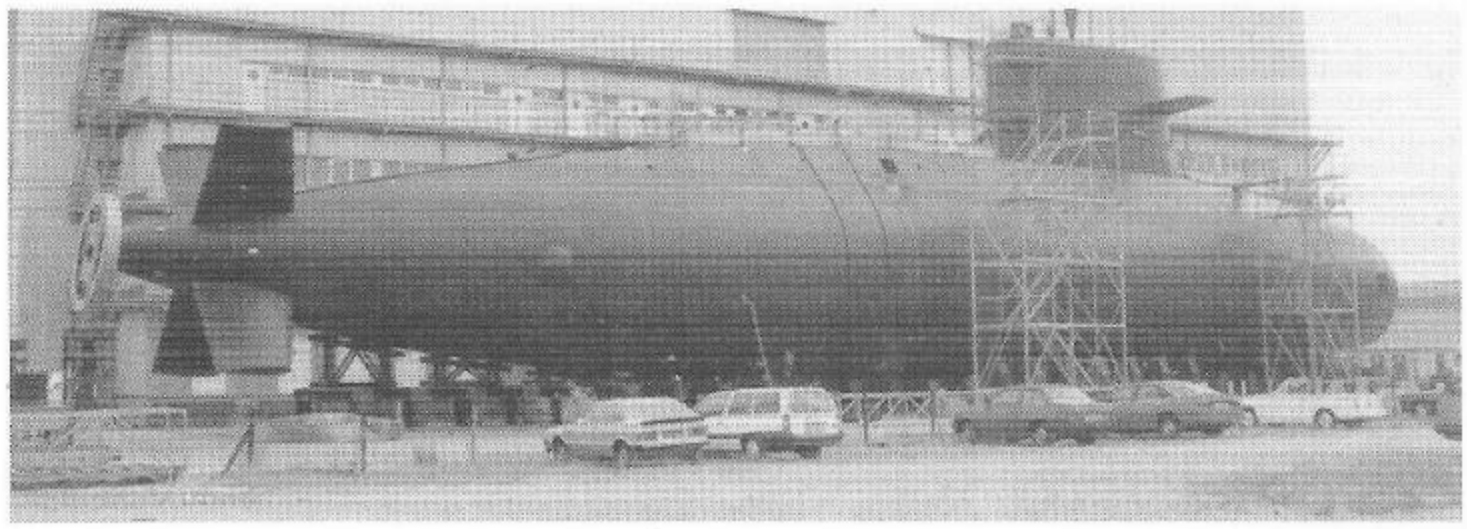
SEWACO VIII is an automated data handling and weapon control system, which was specifically designed for the 'Walrus' class submarines to form the link between the submarine's sensors and its weapons. The main functions of SEWACO are: sonar display and control; contact evaluation; classification; contact motion analysis; tactical plot and general plot functions; weapon control; and simulation and test.

SEWACO consists of seven identical Display and Computer Consoles (DaCCs) with a built-in SMR-MU computer. The large amount of data from the sonars is handled by two extra SMR-MUs, also housed in the CCU. Three types of sonar are fitted (towed array, flank array and circular array), and other sensors and data sources include a noise analyser, ESM facilities, radar, periscopes and position-finding equipment.

The weapon control system controls a mixed load of weapons for subsurface and surface engagements, and the ship's launching system consists of two mutually independent sections, each of which is controlled from a launching system control panel (LSCP). The interface with the weapons (modern subsurface missile) is formed by two identical distribution cabinets. All hardware necessary for the integration of these weapons is included in the distribution cabinet, avoiding the necessity for additional equipment.

Manufacturer/Contractor

Hollandse Signaalapparaten BV, Hengelo, Netherlands.

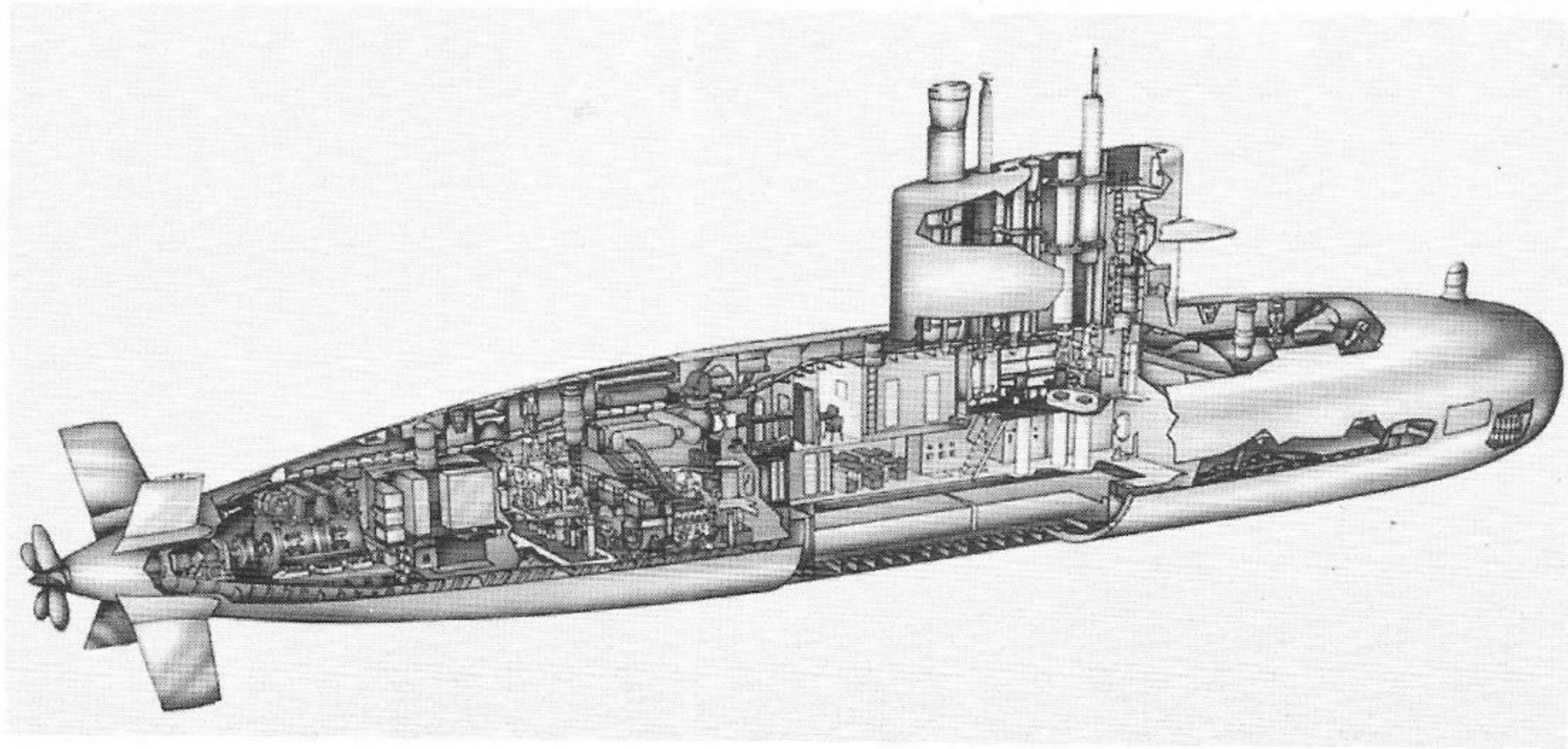


Walrus *(S 802) gives a very clear view of the X-shaped after control surfaces* (H & L van Ginderen Collection)

RADAR

Signaal ZW 07

The ZW 07 radar has been specifically designed to provide navigation, distance measuring, surface search and limited air warning for submarines. A 'single-shot'



Cutaway drawing of 'Walrus' *class submarine*

mode has been adapted for ranging of surface targets and other operational features include: surface coverage up to radar horizon, limited air warning, and high resolution for navigation. Anti-clutter measures and ECCM provisions include: sector scan facilities, logarithmic receiver with pulse length discriminator, suppression of non-correlated pulses, and a tunable transmitter.

Specifications
Frequency: I-band
Polarisation: Horizontal
Transmitter: Tunable magnetron
Power output: 60 kW peak; 100 W average
Max range: 22 km against small surface craft

Manufacturer/Contractor
Hollandse Signaalapparaten BV, Hengelo, Netherlands.

SONARS

Thomson-Sintra TSM 2272 Octopus
TSM 2272 is a development of the French Eledone (DSUV-22) sonar suite, developed specifically for the 'Walrus' class. It is a modular, integrated sonar system which, in the case of the 'Walrus' class includes: a Type 2026 linear towed array, flank arrays, a 64 stave cylindrical bow array, intercept array, and a sail-mounted active array. Functionality includes:

Passive detection, with concurrent broad- and narrowband processing
Automatic anti-jamming, which automatically rejects narrowband jammers, to harden tracks and enhance Contact Motion Analysis (CMA) performance (range, accuracy and convergence delay)
Passive adaptive processing
Automatic track initiation, allowing the operator to avoid repetitive tasks
Interception of all active sonar pulses across the sonar spectrum, from low-frequency surface ship sonars to high-frequency torpedo acoustic heads
The operator can initiate a low-frequency wide sector transmission to determine range accurately, using the passive listening array for reception
Classification, with the spectrum analysis facility (Lofar and Demon) complementing the audio function by providing the operator with specific data in target classification, which is computer-aided through an interactive database

TSM 2233 uses TSM 320 C30, 68020 and 68040 microprocessors for signal processing in MIM D-type host systems communicating internally across high-speed ring networks and externally on standard VME-type busses. Software is in C and Ada.

Manufacturer/Contractor
Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex.

GEC Avionics Type 2026
The Type 2026 is an Anglo-Dutch, clip-on, towed array which forms part of the TSM 2272 sonar suite (see above).

Thomson Sintra DUUX 5
DUUX-5 is also part of the octopus system. This panoramic sonar can track up to three targets simultaneously and incorporates a passive acoustic rangefinder for measuring the range of those three targets within 120° sectors, and a panoramic sonar interceptor measuring the true bearing of all sonar transmissions received in the 2-15 kHz band. It enables range and bearing information on targets to be obtained by the submarine without the need for any transmissions and with minimum delay. Speed of operation permits target course and speed to be computed rapidly, also allowing any changes in either speed or course to be detected without delay. Four targets can be tracked simultaneously (three on radiated self-noise, one on sonar pulses), and there is a continuous panoramic bearing display over 360°. Range information is provided over arcs of 120° on each side of the submarine. Target data is automatically transmitted to the ship's weapon control system and plotting table. Under normal conditions, results in the middle sector are 0.3° for bearing accuracy, 2° discrimination accuracy between two targets and 5 per cent of range on radiated noise for a target at 10 km distance. The hydrophonic unit is composed of two bases with three hydrophones each on the starboard and port sides of the submarine. All other technical details remain classified.

Manufacturer/Contractor
Thomson Sintra Activités Sous-Marines, Sophia Antipolis Cedex, France.

PERISCOPES

Search
Pilkington Optronics CK 24.

Attack
Pilkington Optronics CH 74.

Manufacturer/Contractor
Pilkington Optronics, St Asaph, Clywd, UK.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: *Walrus, Zeeleeuw,* 3 SEMT-Pielstick 12 PA4 200 VG diesels; 4.63 MW (6,300 hp(m)); *Dolfijn, Bruinvis,* Brons-Werkspoor O-RUB 215X12 diesels
Alternators: 3—2.88 MW
Electric motor: 1 Holec; 5.1 MW (6,910 hp(m))
Shaft: 1
Propeller: 1—7-bladed, skew-back
Battery: 3 groups, each of 148 cells

FURTHER INFORMATION

PROGRAMME

Money was set aside in the 1975 Navy Estimates for design work on this class. The contract for building the first of class was signed on 16 June 1979, followed by the contract for the second on 17 December 1979, and for the third and fourth on 16 August 1985.

In 1981 various changes to the design were agreed, the most important of which was to lengthen the hull to accommodate more powerful (and larger) diesel generator sets. The navy also required a substantial increase in diving depth and these combined to result in a delay of one to two years in the programme.

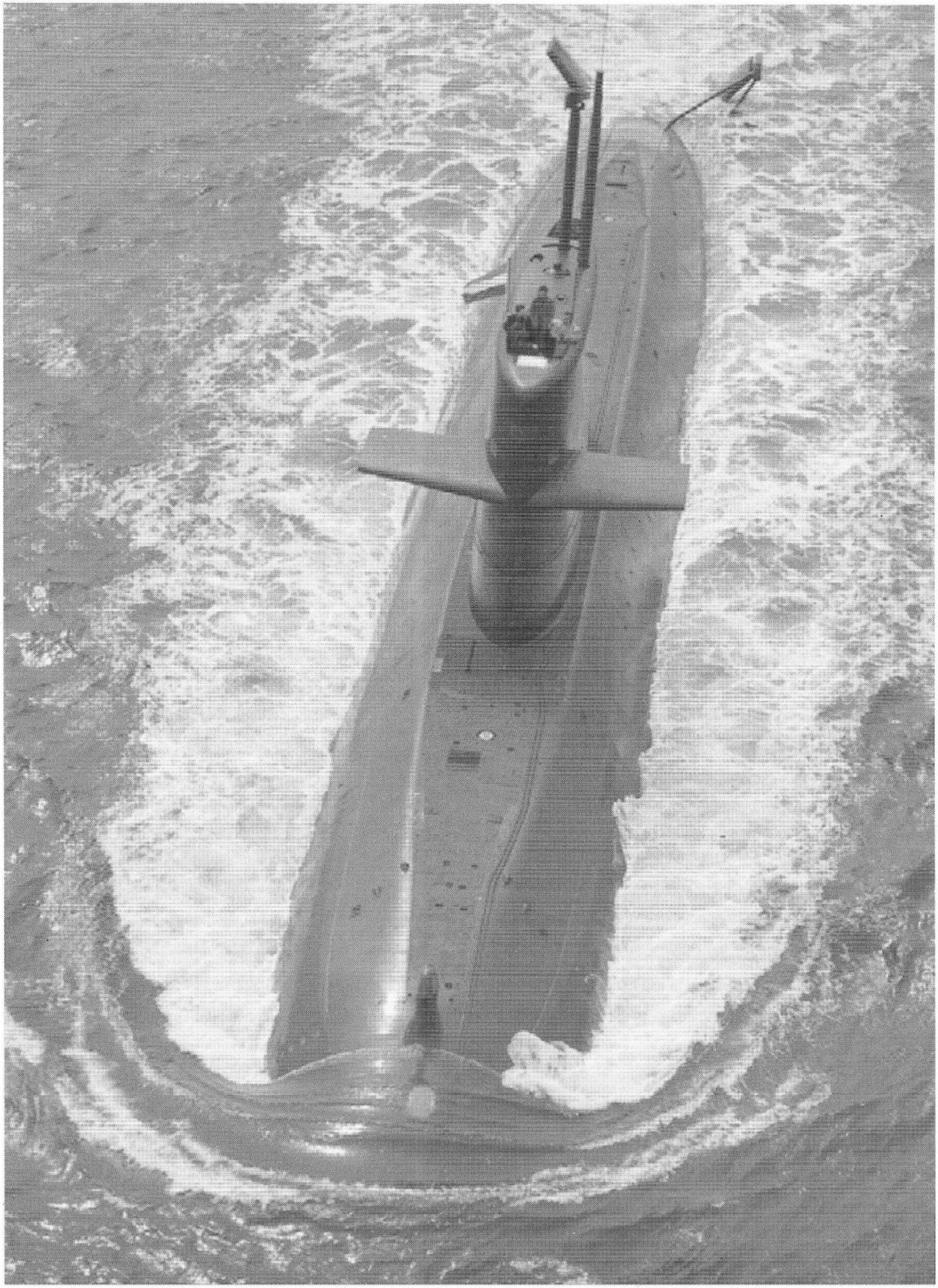
The completion of *Walrus* was delayed by a serious fire, which occurred on 14 August 1986. It did not seriously damage the hull, but it did destroy the cabling and computers.

Zeeleuw then became the effective 'first of class' commencing trials in October 1988, while *Walrus* was rebuilt and then relaunched on 13 September 1989.

There were to have been six in the class but plans for the last two were stopped by the Dutch Parliament in July 1988.

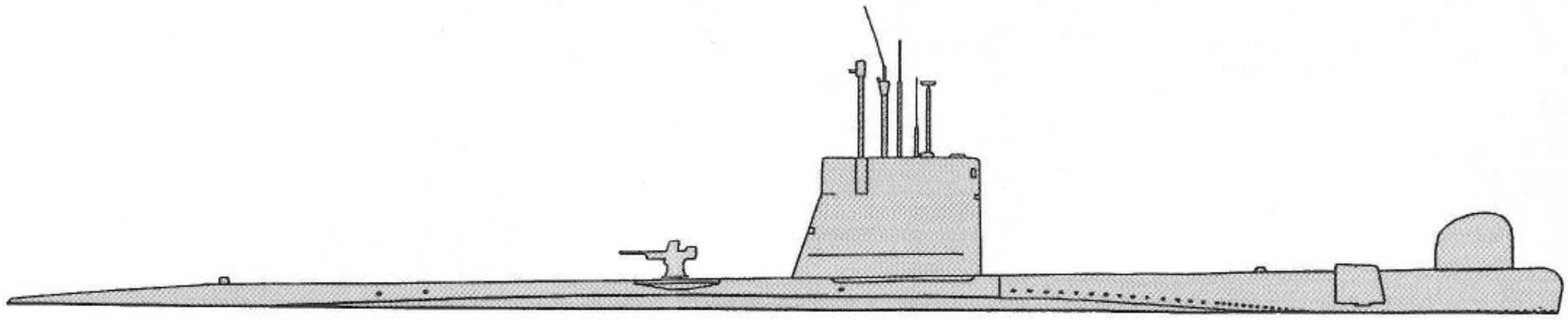
DESIGN

These are essentially 'Improved Zwaardvis' class with similar dimensions and silhouettes except for 'X-configured' after hydroplanes/rudders. Marel high tensile steel is used, which increases the diving depth by some 50 per cent. New Gipsy fire-control and electronic command system fitted and automation reduces the crew from 65 to 50.



'Walrus' class submarine (Netherlands Navy)

ABTAO



Abtao (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Peru

Class: ABTAO
Type: Modified Mackerel

Built: 4
In service: 2

Displacement:
surfaced: 825 t
submerged: 1,400 t

Dimensions
Length: 74.1 m (243.0 ft)
Beam: 6.7 m (22 ft)
Draught: 4.3 m (14 ft)

Speed:
surfaced: 16 kts
submerged: 10 kts
Range, surfaced: 5,000 n miles at 10 kts

Complement: 40

SUBMARINES

DOS DE MAYO (SS 41)

Builder	Electric Boat Company, Groton, Connecticut, USA
Laid down	12 May 1952
Launched	6 Feb 1954
Commissioned	14 Jun 1954

ABTAO (SS 42)

Builder	Electric Boat Company, Groton, Connecticut, USA
Laid down	12 May 1952
Launched	27 Oct 1953
Commissioned	20 Feb 1954

WEAPONS SYSTEMS

TUBES

Six 533 mm (21 in) (four bow, two stern) tubes.

TORPEDOES

Westinghouse Mk 37
Typically active/passive homing to 4.4 n miles (8 km) at 24 knots; warhead 150 kg.

GUNS

One 5 in (127 mm)/25; manual control; line of sight range.

COMMAND AND CONTROL SYSTEMS

RADAR

Navigation, SS-2A; I band.

SONAR

Thomson Sintra Eledone 1102/5; active/passive intercept search and attack; medium frequency.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 General Motors GM 12-278A diesels; 1.8 MW (2,400 hp)

Electric motors: 2 motors
Shafts: 2

FURTHER INFORMATION

PROGRAMME

These submarines have three claims to fame. First, they are the only submarines in the world to retain a deck-gun armament into the 1990s, some thirty years longer than any other navy. Second, they are direct descendants of the 'Mackerel' class, one of the most unpopular types to have served in the US Navy. Third, they are the last submarines to have been built in the USA for an export customer.

The Peruvian Navy approached the US Navy in the late 1940s seeking new submarines which would be somewhat smaller than the surplus 'fleet submarines' then becoming available in large numbers, but would nevertheless incorporate the advances, such as streamlining and extra battery power, then coming into service. Six boats were originally ordered, but this was reduced to four, which were delivered between 1954 and 1957.

DESIGN

The Electric Boat Company based its design for the Peruvian boats on the US Navy's 'Mackerel' class. In the late 1930s the US submarine force had been developing a very satisfactory line of 'fleet submarines' but the surface admirals considered them to be too big, too complicated and far too expensive. Despite the protests of the submarine admirals they were forced to include two smaller boats in their 1938 programme, which became *Mackerel* (SS 204) and *Marlin* (SS 205). They proved to be too small and of little value and were soon relegated to training tasks. Once the war had ended, they were quickly scrapped.

Nevertheless, the design proved to be suitable for the Peruvian requirements, and the hull and sail were streamlined, as requested. To the considerable

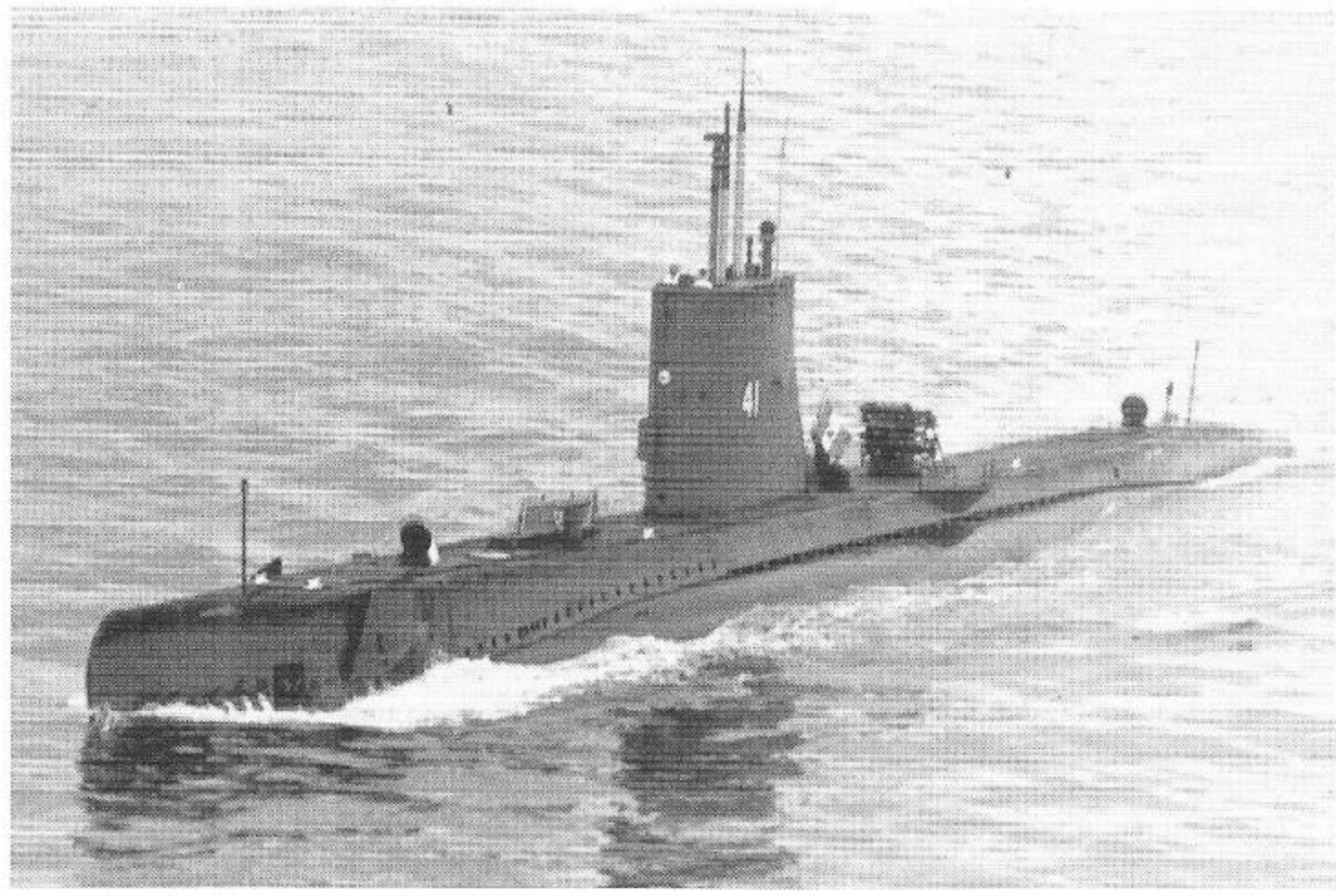
surprise of the Electric Boat Company, however, the Peruvians insisted on a gun, and a 127 mm (5 in)/25 'wet mount' was fitted on the after casing.

MODERNISATION

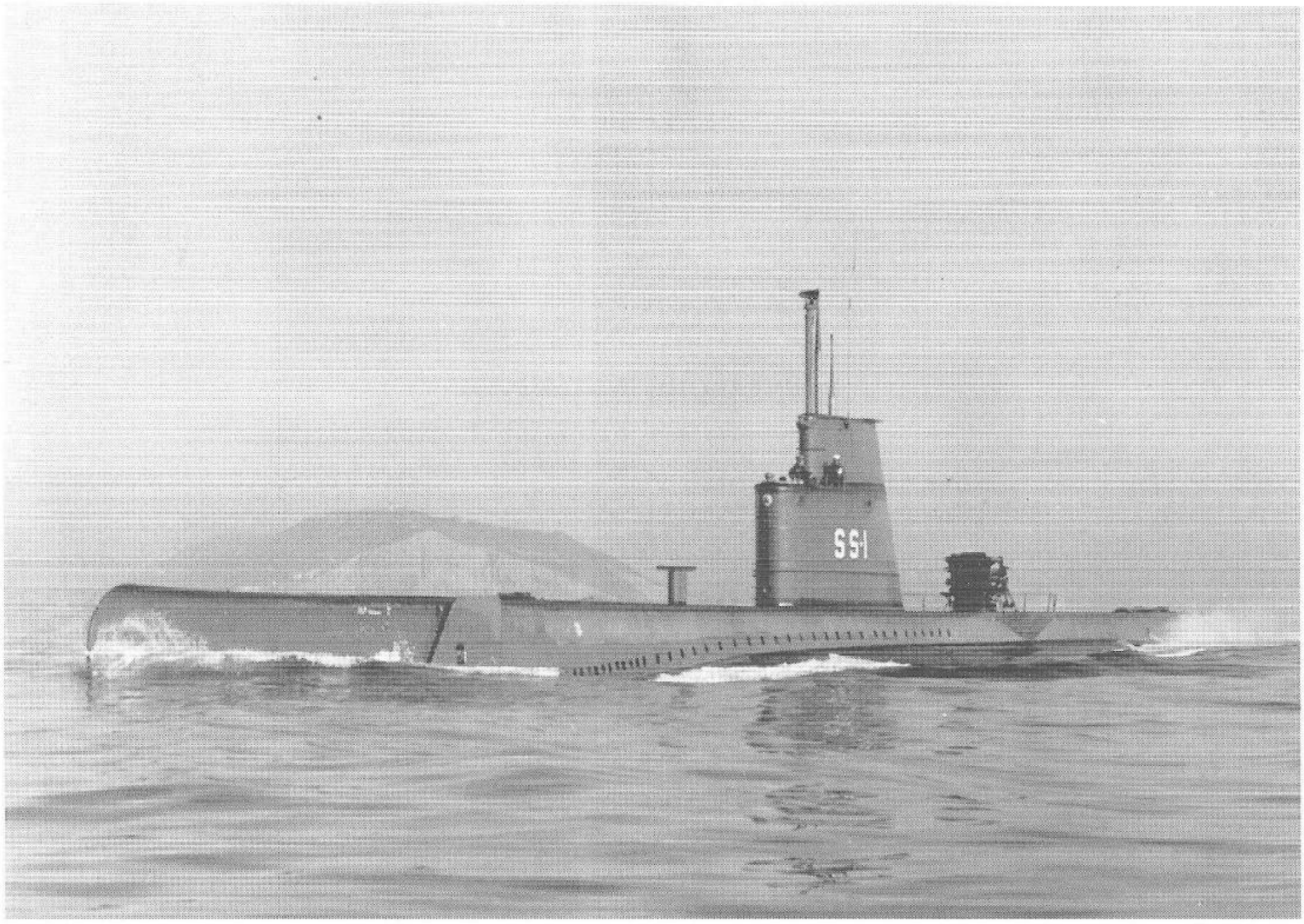
The four submarines were regularly upgraded during their service, with major refits at Electric Boat in 1965 for two boats and the other two in 1968. The work included replacing the original stepped sail with the current model, which is based on that of the Guppy III and removing the deck gun on two of the boats. New batteries were shipped in 1981 and since then the engineering and electrical systems have been modernised and Eledone sonar fitted.

OPERATIONAL

Two boats have been stricken — *Angamos* (S 43) in 1990 and *Iquique* (S 44) in 1993 — but the remaining pair are those retaining the deck guns. Both are used for training and now have reduced diving depth, but would be available in an operational emergency, if required.



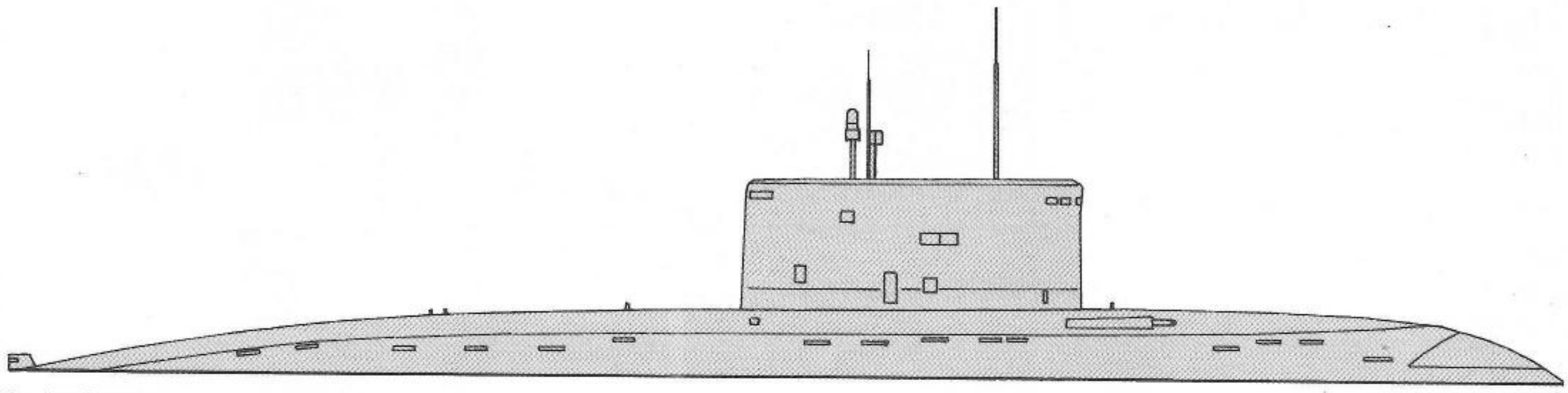
Dos de Mayo *(SS 41) with the new sail and a new pennant number, but still with the 5 in (127 mm gun)* (H & L van Ginderen Collection)



Dos de Mayo *(SS 41) with the original stepped sail. Note the bulk of the 5 in (127 mm) gun on the after casing* (H & L van Ginderen Collection)

KILO

OVERVIEW



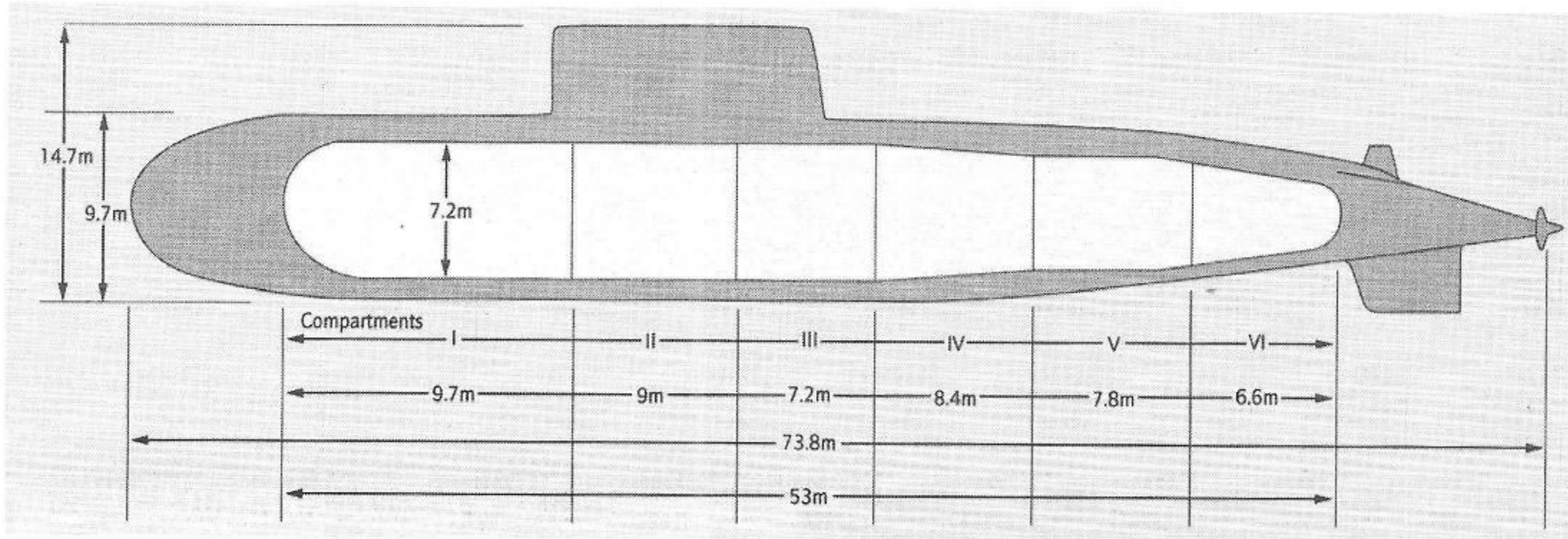
Kilo (Ian Sturton)

The Russian Type 877/636, known to NATO as the 'Kilo' class, is one of the most important diesel-electric submarines of the 1990s, with some 48 in service in seven navies, a number that is likely to grow. It exists in two versions: the original Type 877, which has been produced for both the Russian Navy and export customers, and the later Type 636 which is intended solely for export. The type has two significant achievements to its credit. First, the delivery of two (possibly three) to Iran has dramatically altered the naval strategic situation in the entrance to the Gulf. Second, it has been selected by the Chinese as the new diesel-electric submarine for the PLA-N and in ten years time there may be some 20 (possibly more) of these submarines operating in Asian waters, seriously affecting the balance of naval power in the area.

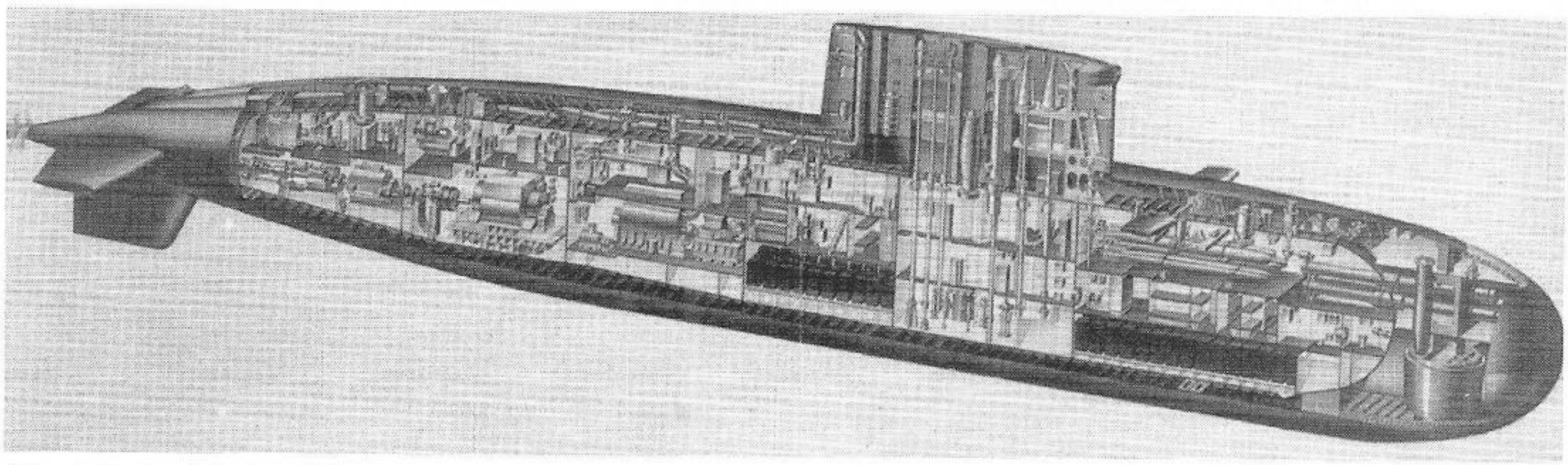
Russian sailor stands in sail of 'Kilo' class submarine to fire an Igla-1M SAM (Rubin)

Type 877

The first Type 877 was essentially a prototype and after launching in 1980 it was rigorously tested by the Soviet Navy, as a result of which many modifications were made to the second and subsequent boats. The hull was radically different to previous Russian diesel-electric submarines, being relatively short and fat, with a single main propeller. It did, however, retain the traditional double hull, which is considered by Russian



Internal division and dimensions of the Type 636 submarine (Rubin)



Cutaway drawing of the Type 636

designers not only to be more survivable, but also to offer invaluable space to accommodate equipment such as the steering gear and high-pressure air bottles outside the pressure hull.

The Type 877 has a reserve buoyancy of 32 per cent, which compares dramatically with Western practice, US nuclear-powered submarines, for example, having a reserve buoyancy of some 13 per cent. Again, this is a long-standing Russian design practice to meet the naval staff requirement that the submarine must remain afloat either with any one compartment and two adjacent main ballast tanks on the same side flooded, or with the stern compartment and the adjacent main ballast tank flooded.

All variants of the Type 877 have common outer hulls with an overall length of 72.6 m (238 ft), and a common pressure hull, 51.8 m (169.9 ft) long. The hull shape was the outcome of original research by Rubin and the Krylov Research Institute, both at St Petersburg, with the large and well-shaped bow not only giving good hydrodynamic and acoustic performance, as well as an optimum shape for the sonar, but enabling six torpedo tubes to be installed.

Five versions of the Type 877 have been produced:

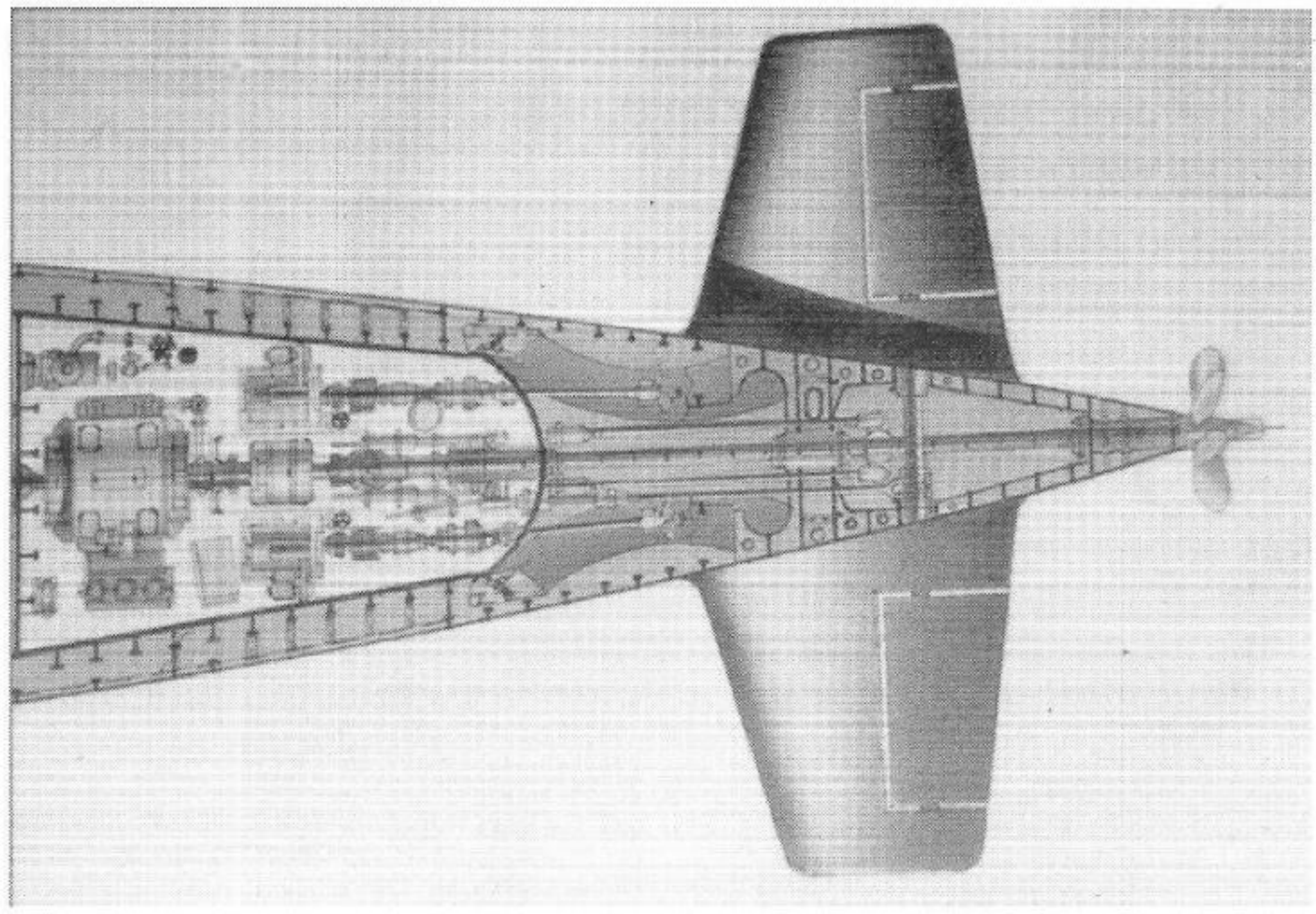
Type 877. The original version which appeared as the class prototype. One only for the Russian Navy.

Type 877M. The improved version incorporating lessons learnt from testing the prototype. Supplied only to the Russian Navy (14).

Type 877EM. The export version of the Type 877M, which was supplied to Algeria (2), India (8), Poland (1) and Romania (1).

Type 877MK. Basically a Type 877M but with a much improved command system. Supplied to the Russian Navy (7).

Type 877EMK. Export version of Type 877MK. Two to the Russian Navy and three to Iran.



The auxiliary system, with two small propellors inside curved ducts. They propel the boat at 3 knots, giving exceptional quietness (David Miller)

Type 636

The Type 636 is the most recent version and is a result of experience with the Type 877, two major considerations being further noise reduction and much greater automation. Noise reduction measures include: mounting the electric motor on a flexibly mounted raft; halving the shaft speed (from 500 to 250 rpm); redesigning many auxiliary systems; revising the bow profile to reduce flow noise yet further; and removing all noise producing equipment from the forward compartment. New, more powerful and more fuel-efficient diesel engines have also been installed, together with more powerful electric motors.

The circular pressure hull is constructed of high-yield steel 24 to 27 mm thick, except in reinforced areas where it is 30 to 35 mm thick. There are three 614 mm diameter access hatches, one each in Compartments I, II and VI, plus a loading hatch in Compartment III. The pressure hull is divided into six compartments by five flat bulkheads, each of which is designed for a hydrostatic pressure of 10 kgf/cm² and is penetrated by an 800 mm diameter hatch.

The exterior of the hull is totally coated in anechoic tiles, the material for which was the subject of considerable research. The tiles are made from rubber with a classified additive, which results in a molecular structure that both absorbs incoming active sonar transmissions and also contains the submarine's own noise. The tiles are approximately 80 cm (2.6 ft) square and are positioned mechanically by means of studs and fixed to the hull using a special adhesive, following which the seams are filled with a hermetically sealing compound. Submarines intended for navies operating in tropical waters are coated in tiles and adhesive using slightly different formulae to optimise performance.

Rubin considers that the flow noise over bow- or sail-mounted forward hydroplanes interferes with the efficiency of the sonar. So, on the Type 877/636 they are positioned on the hull, just forward of the sail, a solution which was also thoroughly tested at the Krylov Institute.

Aft there is a set of horizontal hydroplanes and a single rudder below the hull, research having showed that a vertical fin was not necessary. This has meant, however, that the stern identification and signalling lights have had to be accommodated in a special raised housing just above the waterline, known to the Russians as 'the suitcase.'

The rudder and after-plane rams are driven by the steering hydraulic system, and the forward-plane rams by the ship's hydraulic system, all being controlled by the 'Pirit-23' system in the control centre, which has fully automatic, semi-automatic and manual modes. There are two reserve systems: in the first, the two primary systems back each other up, while in the second, and assuming that all else has failed, there is a manual pump with its own hydraulic fluid supply in Compartment VI to control the rudder.

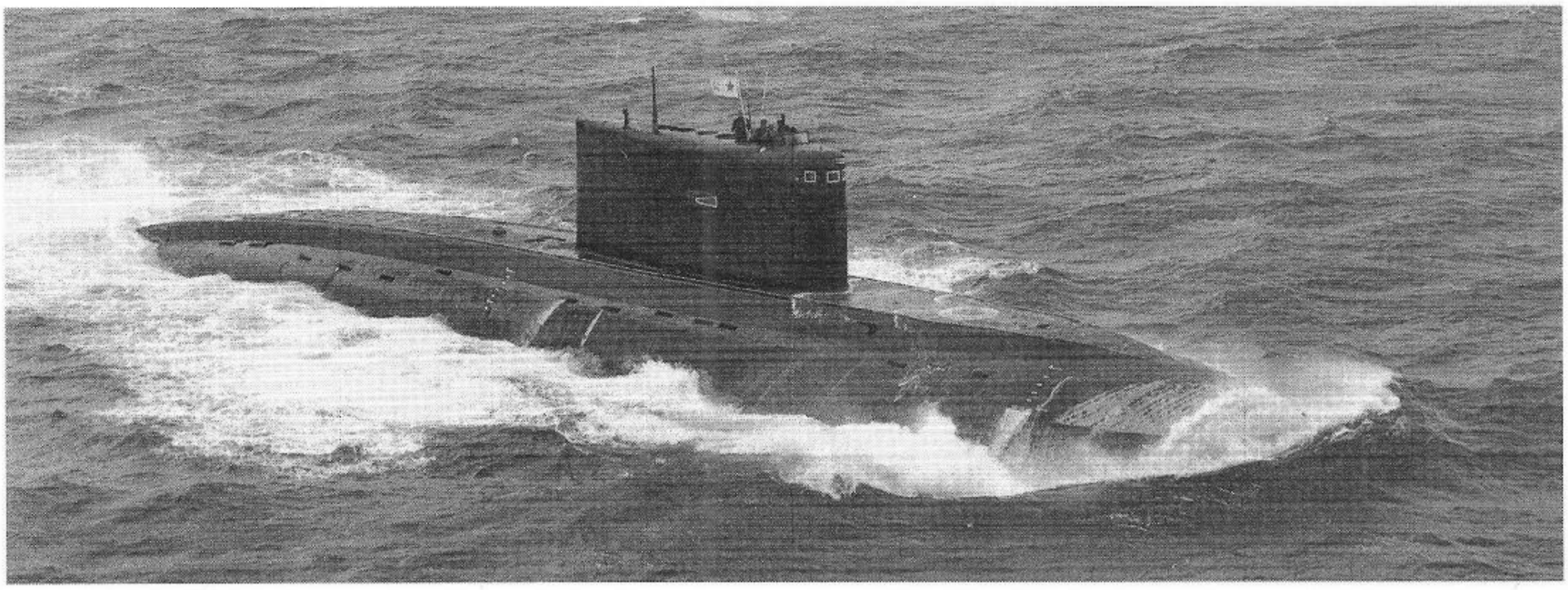
Unusual features

There are two unusual design features, the first of which is the SAM launcher. The Russian Navy was concerned that the submarines might be caught on the surface and insisted that there must be some form of air defense. An automatic SAM system would have been too heavy, so the only option was a manually operated launcher. The launcher and missiles are stored in a watertight container at the bottom of the SAM well, which is located between the snorkel and the radio antenna masts in the sail. The SAM crew consists of two men: a launcher operator and a loader who extracts new rounds from the missile container.

Both Type 636 and Type 877 have an unusual auxiliary propulsion system. When the Type 877 was in the design stage, Soviet Navy submarine officers were used to their submarines having three propellers and were concerned at losing the safety margin which that entailed. The Rubin design team, therefore, included two small, auxiliary propellers, each driven by an MT-168 75 kW electric motor. These are housed in two 4 m (13 ft) long tunnels in the stern casing with hydraulically operated entrance and exit doors. These propel the submarine at some 3 knots and not only are they available for use in a 'get you home' role, but they are also regularly used for mooring, and for traversing restricted waterways.

Combat Information System

The Type 877 is equipped with what Western submariners describe as a 'simple, but thoroughly workmanlike, manual command and control system'. The Type 636, however, has a much more advanced, automated



Russia's 'Kilo class', one of the most successful contemporary diesel-electric submarines

system, in which all sensor inputs are integrated and their data fused by the MVU-110EM, a fully digital, three processor, combat information system, which provides automatic task solution, with five targets being tracked simultaneously, of which two are auto-tracked, while the other three must be manually controlled.

Particular attention has been paid to the commanding officer in order to ensure that he can perform his tasks as efficiently as possible, and he is given special displays to ensure that he has the fullest possible information to help him in his decision making. In addition to the commanding officer, there are separate displays for the navigator, dosimeter operator and the sonar operator.

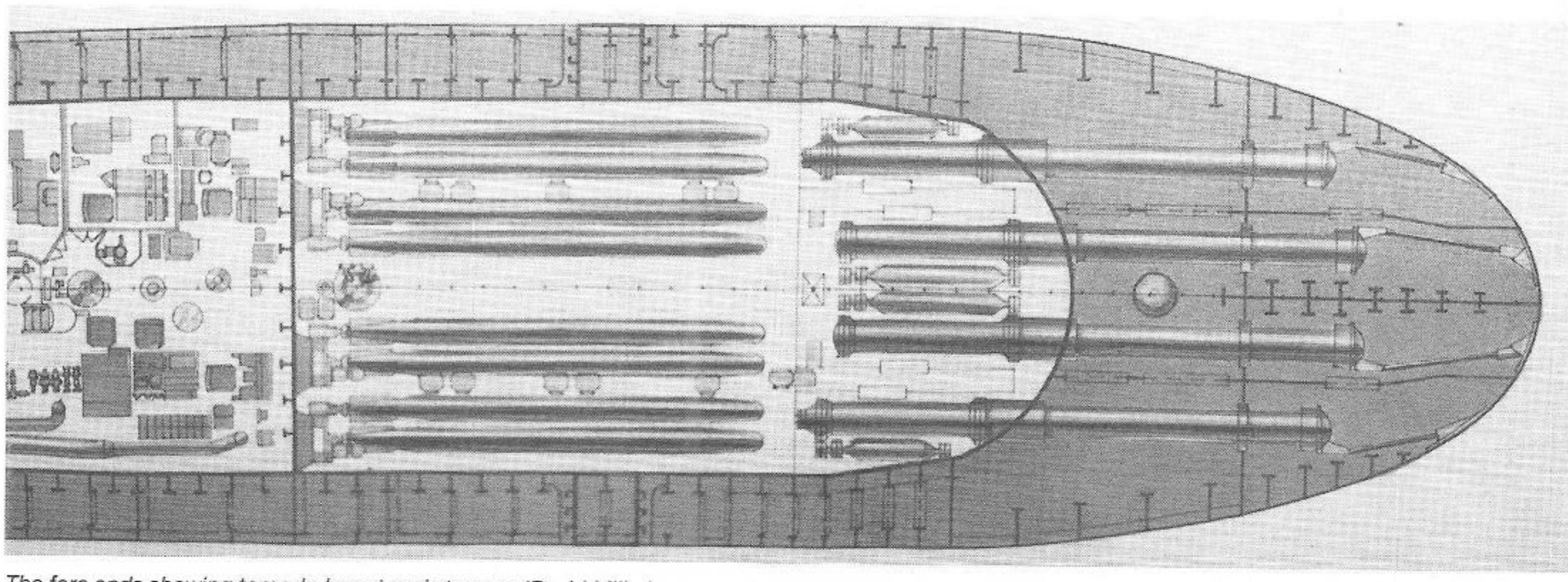
Despite the qualities of this Russian system, US company Rockwell Autonetics Electronic Systems has signed an agreement with Rubin to install its combat systems in export Type 877s or Type 636s. Such a combat system would probably be based on the architecture used in the Australian 'Collins' class.

Propulsion

The lead-acid storage battery consists of two groups, each of 120 Type 446 cells, which are located under the lower deck in Compartments I and II. The Russians claim that these cells are very efficient, but there have been reports that the Iranian Navy has had problems with batteries, although this could be due to either an unexpectedly high temperature humidity operating environment or to the inexperience of the crews (or a mixture of the two). At least one other manufacturer, British Chloride Industrial Batteries Ltd, markets cells with a 5-year guaranteed life, which are specifically designed for the Type 877/636 submarines.

Sensors

There are seven masts, which can be operated on the surface without restriction, or at the periscope depth (17.5 m) at speeds of 8 to 10 knots and in a maximum of Sea State 5. There are two attack periscopes (magnification ×1.5 and ×6), and elevation limits of −10 to +90° and both can be trained through 360°. There are also masts for radio direction-finding, radar, radio navigation, and for HF and HF/VHF antennas. Finally, there is the snort intake, which incorporates the exhaust outlet.



The fore-ends showing torpedo layout and stowage (David Miller)

KILO, RUSSIA

GENERAL SPECIFICATION

Country: Russia

Class: KILO (GRANAY)
Type: 877/877K/877M/636

Built: 24
Building: 0
In service: 24

Displacement:
surfaced: 2,325 t
submerged: 3,076 t

Dimensions
Length: Type 877—72.6 m (238.2 ft)
Type 636—73.8 m (242.1 ft)
Beam: 9.9 m (32.5 ft)
Draught: 6.6 m (21.7 ft)

Speed:
surface: 10 kts
snorting: 9 kts
submerged: Type 877—17 kts; Type 636—19 kts
reserve propulsion motors (surfaced/submerged): 3 kts
Diving depth:
periscope: 17.5 m (57.4 ft)
normal: 240 m (787 ft)
max: 300 m (984 ft)
Turning diameter:
surfaced: 6-7 lengths
submerged: 4-5 lengths

Endurance: 45 days
Range:
snorting: Type 877—6,000 n miles at 7 kts; Type 636—7,500 n miles at 7 kts
submerged: 400 n miles at 3 kts

Complement: 52 (13 officers)

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Strela/Igla-M (NATO = SA-N-5/-8)

Launcher and missiles are stored in a watertight container at the bottom of the SAM well, located between the snorkel and the radio antenna masts in the sail. The SAM crew consists of the launcher operator and the loader who extracts new rounds from the missile container. The Type 877 is armed with a Strela launcher (NATO = SA-N-5) and eight missiles, while the Type 636 is equipped with the more up-to-date Igla-1M launcher (NATO = SA-N-8) and six missiles.

Specifications

Russian designation: Strela 2 (NATO = SA-N-5 (Grail))
Carried in: Type 877
No of missiles carried: 8
Length: 1.45 m (4.75 ft)
Diameter: 7 cm (2.76 in)
Weight: 9.97 kg (21.98 lb)
Speed: Mach 1.7
Range: 2.6 n miles (5.5 km)
Altitude: 18-4,500 m (60-14,800 ft)

Russian designation: Igla-M (NATO = SA-N-8 (Gimlet))
Carried in: Type 636
Number carried: 6
Length: 1.55 m (5.08 ft)
Diameter: 80 cm (31.5 in)
Weight: 10.8 kg (23.8 lb)
Speed: Mach 1.67
Range: 600 m-5 km (2.7 n miles)
Altitude: 10-3,500 m (33-11,500 ft)

Manufacturer/Contractor

Fakel Machine Building and Design Enterprise, Khimky-5, Moscow, Russia.

TUBES

Six 533 mm (21 in) torpedo tubes; compressed-air launch.
Total weapon load, 18 (six in the tubes, 12 in racks).

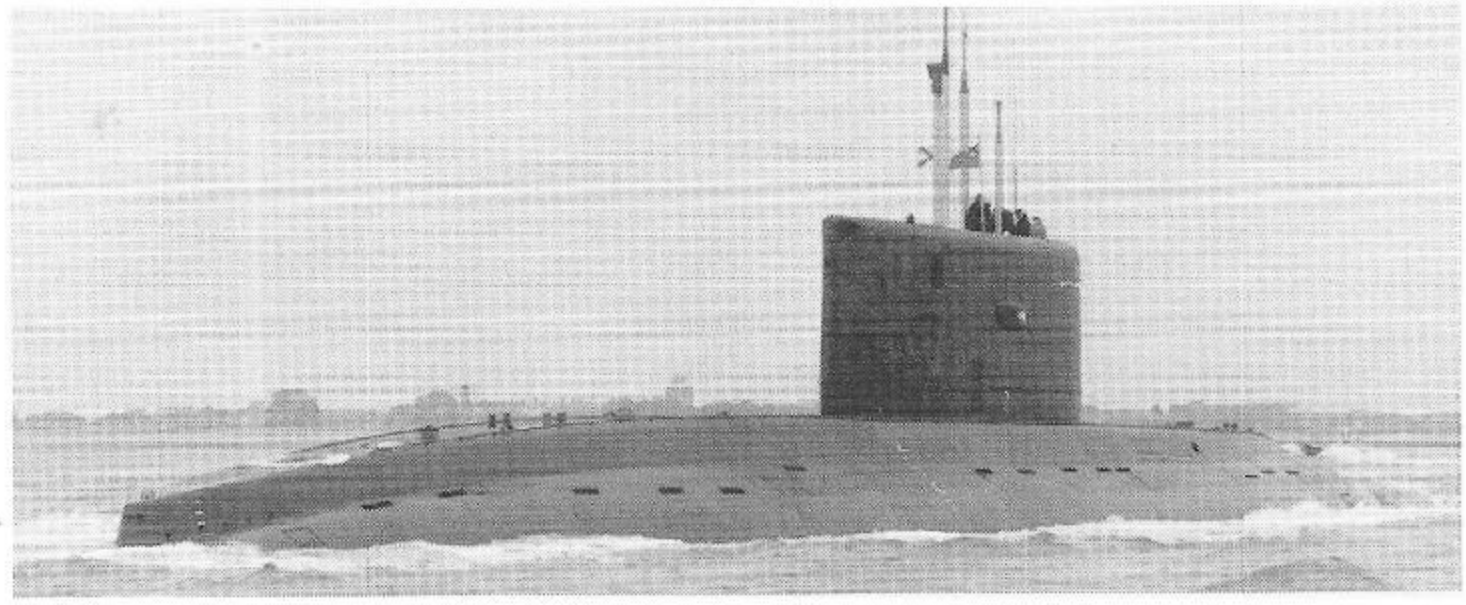
TORPEDOES

Six of the torpedoes can be TEST-71ME wire-guided torpedoes, which can only be launched from Nos 1 and

2 tubes. Other torpedoes include Types 53-65KE, 53-56B, 53BA and CET-53ME. Each tube is fitted with a quick-loading device, the first to be used in a Soviet diesel-electric submarine, which is similar to but smaller than those used in SSNs. With the six tubes loaded, and depth and speed preset, the first salvo can be fired in 15 seconds, followed by the second salvo 2 minutes later and the third salvo 5 minutes after that. Launch can take place at depths varying between 15 m (periscope depth) and 240 m, at speeds between 2.5 and 19 knots.

MINES

AM-1 mines can be carried instead of torpedoes, twelve in the tubes, with twelve reloads in the racks. These mines can be laid at a maximum depth of 50 m (164 ft) and speeds of 2.5 to 6 knots.



Russian Navy 'Kilo' class submarine, Number 431. Note that this does not have the stern light in the 'suitcase' (H & L van Ginderen Collection)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

MP П -25 Э
This set, known to NATO as Brick Pulp, provides 360° coverage against linear-polarised over-the-horizon emissions. Detection range against an airborne emitter flying at a height of 500 m in the 3 cm waveband and transmission power of 108 W is 70-100 km ±15 per cent.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

MBY-110 Э
The MBY-110 Э combat information system performs a variety of tasks, including automatic task solution and the acquisition, processing and display of tactical situation information. It also provides the inputs for torpedo launching, combat manoeuvres and navigation. Finally, there is a built-in training function. Subsystems of the MBY-110 Э include a digital computer, commanding officer's panel, navigator's panel, target indication panel and torpedo data input devices.

COMMUNICATIONS AND DATALINKS

Transmitter P-654- П P
Two sets covering 1.5-24 MHz.

Receiver P-680-1
Three sets covering 1.5-60 MHz.

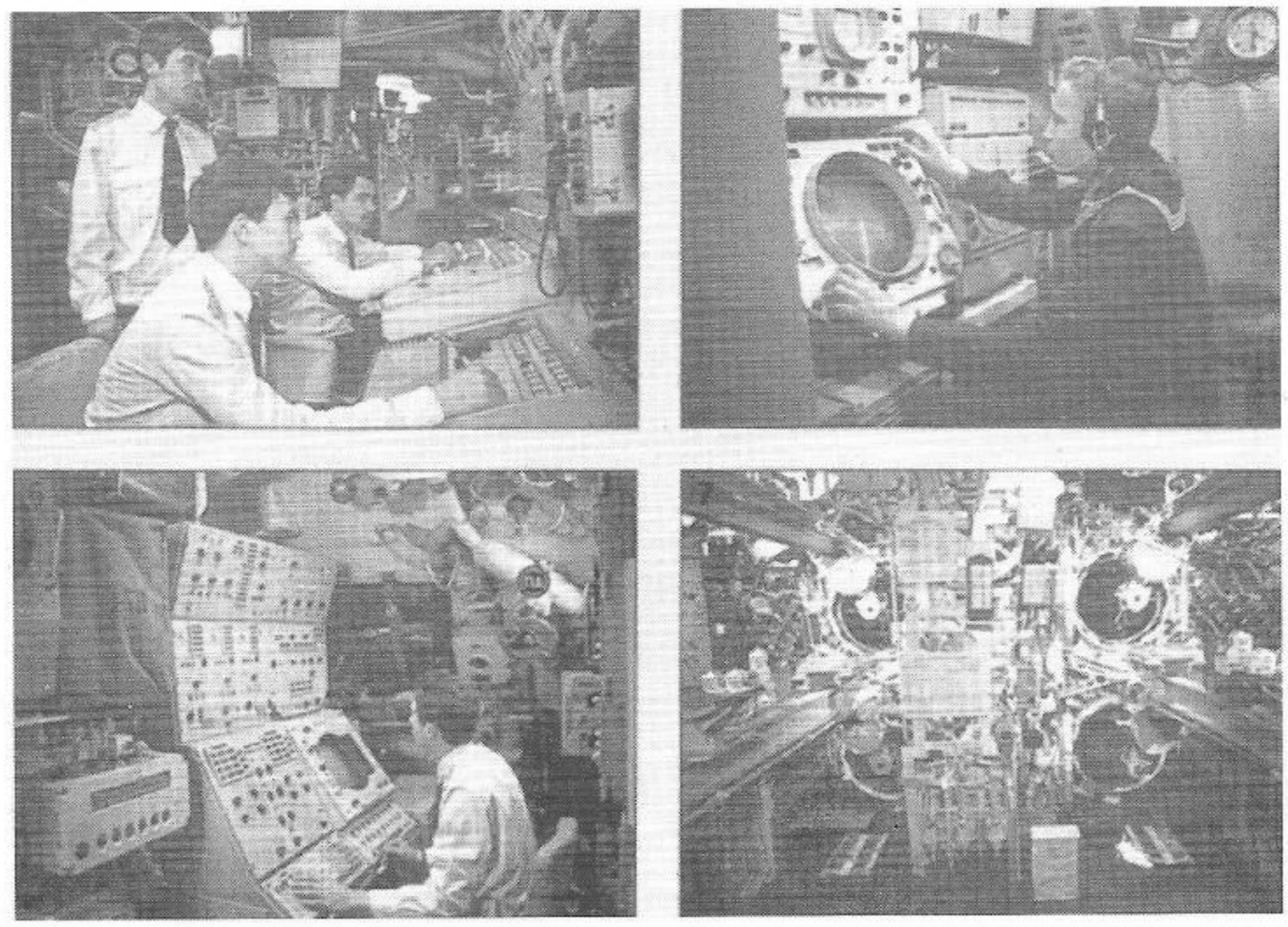
Receiver P-683-1
One set covering 3-100 kHz.

Transceiver P-625
Covers frequencies 100-150 MHz and 220-400 MHz for two-way, line of sight voice (AM) or telegraph communications.

Transceiver P-608H
Emergency portable radio station on international distress frequencies (500 and 2182 kHz) and eight fixed frequencies: 3.6-3.8; 4.5-4.7; 6.1-6.3; 8.2-8.4; 10.0-10.3; 12.4-12.7; 16.5-16.8; 20.0-22.4 MHz.

RADAR

MPK-50 Э
MPK-50 Э is used for surface and air search and navigation. Detection range against a frigate-sized surface target is 16 km ±15 per cent.



Control room and torpedo room in a Russian Type 636 (Rubin)

SONARS

M Г K-400
The MГK-400 (NATO = Shark Teeth) active/passive sonar array is located in the bow, with a large number of transducers mounted in a titanium cylinder. Typical detection performance in the passive mode is 16 to 20 km against submerged targets and 60 to 80 km against surface targets. In the active mode the system can provide range data on submerged targets at ranges of 16 to 20 km, and it can also be used for long-range (60 to 80 km) and short-range (20 to 25 km) telephone or telegraph communications with other similarly equipped submarines in either telephone or telegraph modes. On the surface, the sonar can be reached through a tunnel in the bow casing, and individual transducers can be easily replaced. Neither flank nor towed arrays are fitted, Rubin stating that the performance of the MГK-400 fully meets the requirements of the Type 877/636's role.

M Г -519
Anchored mines can be detected at up to 1,500 m (1,641 yd) by the MГ-519 hydroacoustic mine detection sonar, while the MГ-553 set measures sound velocity in water in the range 1,440-1,560 m/s with an accuracy of ±6 m/s.

M Г -512
MГ-512 station detects the start of propeller cavitation by measuring sound pressure of 0.05 N/m² in the frequency band 10-30 kHz.

PROPULSION

Specifications
System: Diesel-electric
Diesel generators: 2 diesel generators, each comprising 4-2ДД42M engine and ПГ-142 DC generator. The 4-2ДД42M is a 4-stroke, 6-cylinder, in-line engine with gas-turbine supercharging, each giving 1,100 kW (1,500 hp) at 700 rpm; 2 Type ПГ-142 generators, rated at 1,000 kW each

Electric motor:
Type 877: 1 Type ПГ-141; 4,050 kW (5,500 hp); 485±5 rpm; 430-360 V

Type 636: A motor of similar power, but longer in length
Cruise motor: 1 Type ПГ-140; 139 kW (190 hp); 150 rpm; 320-190 V (on main drive shaft)

Reserve propulsion motors: 2 Type ПГ-168; 75 kW (102 hp); 650±10 rpm; 320-200 V
Battery: 3 groups, each of 120 Type 446 cells, rated at 100 A at 9,700 kW h capacity

Propellers:
Type 877: 6-bladed propeller
Type 636: 7-bladed, skewed-blade propeller, developed by the Krylov Research Bureau

EMERGENCY SYSTEMS

FIREFIGHTING

An air-foam smothering system consists of two stations, one at either extremity of Compartments I and VI, both of which have a reservoir of foam-forming liquid, a proportioner and the necessary fittings. The two stations are connected by a special pipeline, with hose-reels in every compartment. The chemical firefighting system has one station in every compartment, with a freon reservoir and an air bottle. Each station is able to deal with a fire in its own and each adjacent compartment, thus giving guaranteed cover by two systems in Compartments I and VI, and three in all the others.

ESCAPE FACILITIES

For major emergencies, the submarine is equipped with an underwater location beacon, and a manually ejected signal buoy on the after casing. There are full facilities for the crew to escape from a sunken submarine and there are also three hardpoints for connection to pontoons, which enable the submarine to be recovered with any one compartment completely flooded. There is also a connector in the superstructure for divers to connect an air hose to blow the main ballast tanks. Liferafts and two small inflatable boats are stored in the fin.

RADIATION MONITORING

The submarine carries a variety of radiation monitoring devices, including:

КИД-6Г individual dosimeter to measure gamma-radiation dose

КДГ-1 gamma-ray dosimeter

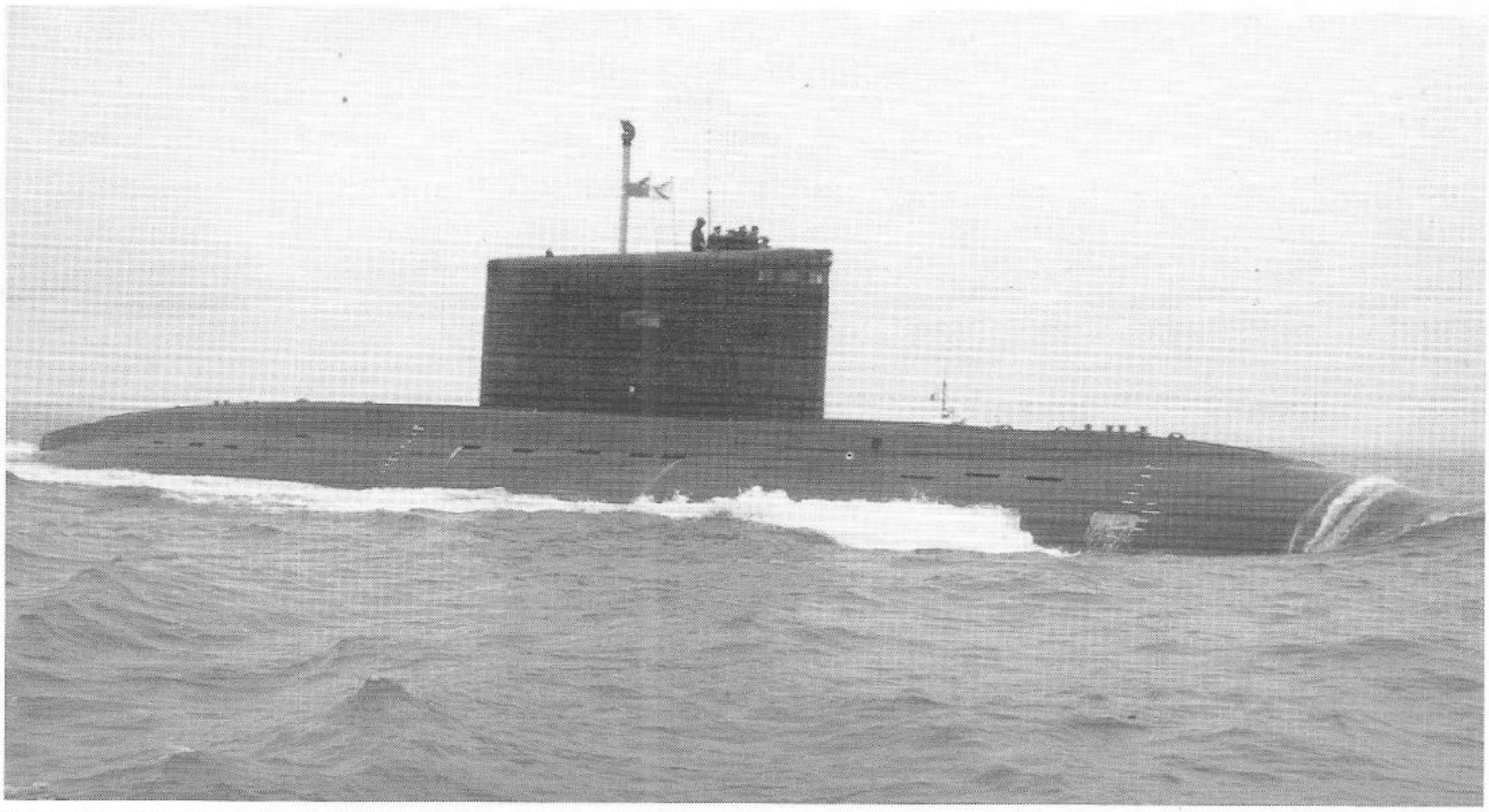
Д3ГХ-02 collective gamma-ray dosimeter

КДУ-6А submarine dosimetric device to monitor seawater, external air and internal atmosphere, to determine individual gamma-ray exposure.

FURTHER INFORMATION

OPERATIONAL

Two Type 877s are based in the Black Sea Fleet and two in the Baltic Fleet. Six are in the Northern Fleet and the remaining 14 in the Pacific Fleet. It should be noted that new versions for export are always tested first by the Russian Navy.



Russian Navy 'Kilo' class arrives in Portsmouth, UK in 1995 (Jane's/HM Steele)

KILO, ALGERIA

GENERAL SPECIFICATIONS

Country: Algeria

Class: KILO
Type: 877E

Purchased: 2
In service: 2

Displacement:
surfaced: 2,325 t
submerged: 3,076 t

Dimensions
Length: 73.8 m (242.1 ft)
Beam: 9.9 m (32.5 ft)
Draught: 6.6 m (21.7 ft)

Speed:
surfaced: 10 kts
snorting: 9 kts
submerged: 17 kts

Range:
snorting: 6,000 n miles at 7 kts
submerged: 400 n miles at 3 kts
Diving depth:
normal: 240 m (787 ft)
max: 300 m (985 ft)

Complement: 52 (13 officers)

SUBMARINES

Rais Hadj Mubarek (012)

Builder	Admiralty Yard, St Petersburg, Russia
Laid down	1985
Launched	1986
In service	Oct 1987

El Hadj Slimane (013)

Builder	Admiralty Yard, St Petersburg, Russia
Laid down	1985
Launched	1987
In service	Jan 1988

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Strela 2 (NATO = SA-N-5)

Launcher and missiles are stored in a watertight container at the bottom of the SAM well, located between the snorkel and the radio antenna masts in the sail. The SAM crew consists of the launcher operator and the loader who extracts new rounds from the missile container.

Specifications

Russian designation: Strela 2
NATO designation: SA-N-5 (Grail)
Carried in: Type 877
No of missiles carried: 8
Length: 1.45 m
Diameter: 7 cm
Weight: 9.97 kg
Speed: Mach 1.7
Range: 2.6 n miles (5.5 km)
Altitude: 18-4,500 m

Manufacturer/Contractor

Fakel Machine Building and Design Enterprise, Khimky-5, Moscow, Russia.

TUBES

Six 533 mm (21 in) torpedo tubes; compressed air launch.
Total weapon load, 18 (six in the tubes, 12 in racks).

TORPEDOES

TEST-71ME

Six torpedoes can be TEST-71ME wire-guided torpedoes launched from Nos 1 and 2 tubes only. Other torpedoes include Types 53-65KE, 53-56B, 53BA and CET-53ME.

MINES

AM-1

Up to 24 AM-1 mines can be carried instead of torpedoes, but there is no confirmation that Algeria has bought such weapons.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

MP П -25 Э radar warning

MPП-25 Э gives warning of airborne and seaborne radar emitters.

COMMAND AND CONTROL SYSTEMS

RADAR

MPK-50 Э

MPK-50 Э I-band, surface- and air-search and navigation radar.

SONARS

MГK-400

The MГK-400 active/passive sonar array is located in the bow, with a large number of transducers mounted in a titanium cylinder. Typical detection performance in the passive mode is 16 to 20 km against submerged targets and 60 to 80 km against surface targets. In the active mode the system can provide range data on submerged targets at ranges of 16-20 km, and it can also be used for long-range (60 to 80 km) and short-range (20 to 25 km) telephone or telegraph communications with other similarly equipped submarines in either telephone or telegraph modes. On the surface, the sonar can be reached through a tunnel in the bow casing, and individual transducers can be easily replaced. Neither flank nor towed arrays are fitted, Rubin stating that the performance of the MГK-400 fully meets the requirements of the Type 877's role.

M Г -519

MГ-519 is a hydroacoustic mine-detection sonar.

M Г -553

MГ-553 measures sound velocity in water.

M Г -512

MГ-512 detects propeller cavitation.

PROPULSION

Specifications

System: Diesel-electric
Diesel generators: 2—4-stroke, 6-cylinder, in-line, Model 4-2AA-42M engines with gas-turbine supercharging, each giving 1,500 kW at 700 rpm. Two Type ПГ-142 generators, rated at 1,000 kW each
Electric motor: 1 Type ПГ-141; 4,050 kW (5,500 hp); 485±5 rpm; 430-360 V
Cruise motor: 1 Type ПГ-140; 139 kW (190 hp); 150 rpm; 320-190 V
Reserve propulsion motors: 2 Type ПГ-168; 75 kW (102 hp); 650±10 rpm; 320-200 V
Battery: 2 groups, each of 120 Type 446 cells, rated at 100A at 9,700 kW h capacity
Shafts: 1
Propeller: 1 six-bladed propeller

FURTHER INFORMATION

PROGRAMME

The Algerian Navy obtained two Soviet 'Romeo' class, its first-ever submarines, in 1982 and 1983, and these were replaced in October 1987 and January 1988 by the two Kilos. Both were new-construction hulls of the export version of the first production model, Type 877E.

After no more than five years' service, one went to St Petersburg for refit in June 1993 and returned in May 1995, the refit having taken considerably longer than had been expected. The second started its refit in late 1993 and was due to return to Algeria at some time in 1996. Both submarines were, therefore, unavailable for deployment for well over a year, suggesting a lack of operational urgency.

KILO, PEOPLE'S REPUBLIC OF CHINA

GENERAL SPECIFICATIONS

Country: People's Republic of China

Class: KILO
Type: 877EKM/636

Built: 2 (Type 877EKM)
Building: 2 (Type 636)
In service: 2

Displacement:
surfaced: 2,325 t
submerged: 3,076 t

Dimensions
Length: 73.8 m (242.1 ft)
Beam: 9.9 m (32.5 ft)
Draught: 6.6 m (21.7 ft)

Speed:
surfaced: 10 kts
snorting: 9 kts
submerged: 17 kts
Range:
snorting: 6,000 n miles at 7 kts
submerged: 400 n miles at 3 kts

Diving depth:
normal: 240 m (787 ft)
max: 300 m (985 ft)

Complement: 52 (13 officers)

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Strela 2 (NATO = SA-N-5)
Launcher and missiles are stored in a watertight container at the bottom of the SAM well, located between the snorkel and the radio antenna masts in the sail. The SAM crew consists of the launcher operator and the loader who extracts new rounds from the missile container.

Specifications
Russian designation: Strela 2
NATO designation: SA-N-5 (Grail)
Carried in: Type 877
No of missiles carried: 8
Length: 1.45 m
Diameter: 7 cm
Weight: 9.97 kg
Speed: Mach 1.7
Range: 2.6 n miles (5.5 km)
Altitude: 18-4,500 m

Manufacturer/Contractor
Fakel Machine Building and Design Enterprise, Khimky-5, Moscow, Russia.

TUBES

Six 533 mm (21 in) torpedo tubes; compressed air launch.
Total weapon load, 18 (six in the tubes, 12 in racks).

TORPEDOES

TEST-71ME
Six torpedoes can be TEST-71ME wire-guided torpedoes launched from Nos 1 and 2 tubes only. Other torpedoes include Types 53-65KE, 53-56B, 53BA and CET-53ME.

MINES

Up to 24 AM-1 mines can be carried instead of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

MP П -25 Э radar warning
MPП-25 Э gives warning of airborne and seaborne radar emitters. Squid Head or Brick Pulp; radar warning.

COMMAND AND CONTROL SYSTEMS

RADAR

MPK-50 Э
MPK-50 Э (NATO = Snoop Tray) I-band, surface and air search and navigation radar

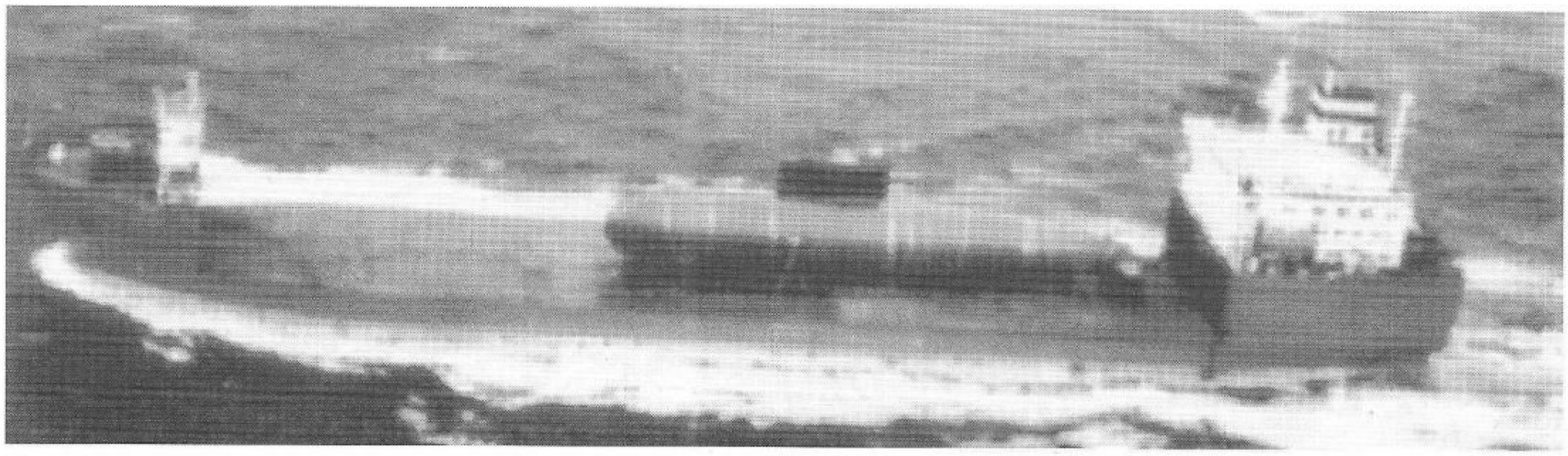
SONARS

M Г K-400
The MГK-400 (NATO = Shark Teeth) active/passive sonar array is located in the bow, with a large number of transducers mounted in a titanium cylinder. Typical detection performance in the passive mode is 16 to 20 km against submerged targets and 60 to 80 km against surface targets. In the active mode the system can provide range data on submerged targets at ranges of 16 to 20 km, and it can also be used for long-range (60 to 80 km) and short-range (20 to 25 km) telephone or telegraph communications with other similarly equipped submarines in either telephone or telegraph modes. On the surface, the sonar can be reached through a tunnel in the bow casing, and individual transducers can be easily replaced. Neither flank nor towed arrays are fitted, Rubin stating that the performance of the MГK-400 fully meets the requirements of the Type 636's role.

M Г -519
MГ-519 is a hydroacoustic mine detection sonar

M Г -553
MГ-553 measures sound velocity in water

M Г -512
MГ-512 detects propeller cavitation



Cypriot-flagged merchant ship Sea Tern *carrying a Russian-built Project 877EKM submarine for delivery to China in February 1995*

PROPULSION

Specifications
System: Diesel-electric
Diesel generators: 2 diesel generators, each comprising 4-2ДЛ42M engine and ПГ-142 DC generator. The 4-2ДЛ42M is a 4-stroke, 6-cylinder, in-line engine with gas-turbine supercharging, each giving 1,100 kW (1,500 hp) at 700 rpm; 2 Type ПГ-142 generators, rated at 1,000 kW each
Electric motor: 1 Type ПГ-141; 4,050 kW (5,500 hp); 485±5 rpm; 430-360 V
Cruise motor: 1 Type ПГ-140; 139 kW (190 hp); 150 rpm; 320-190 V (on main drive shaft)
Reserve propulsion motors: 2 Type ПГ-168; 75 kW (102 hp); 650±10 rpm; 320-200 V
Battery: 2 groups, each of 120 Type 446 cells, rated at 100 A at 9,700 kW h capacity
Propellers: 6-bladed propeller

FURTHER INFORMATION

PROGRAMME

The initial Chinese order for four Kilos was placed in mid-1993, with the first delivery being made by a sea transporter vessel in February 1995. The second boat arrived in November 1995 by the same method. These two boats were both Type 877EKM, which had been ordered by an East European country and then cancelled.

The remaining two of this first order are Type 636s and are currently under construction at St Petersburg, with delivery scheduled for 1997/1998. Negotiations are under way for at least six more, which may include a licence to construct the later hulls in China.

MODIFICATIONS

Some modifications have already been carried out to the hulls that have arrived in China. The work is believed to have included the installation of a different ESM system.

DEPLOYMENT

The Kilos are based at Zhanjiang in the South Sea Fleet.

COMMENT

Despite wishing to promote their own submarine design and construction industry, and the continued production of the Song and Ming designs, the Chinese have managed to make a major technological leap forward with this order. At a stroke they have gained access to hull, sensor, quietening and weapon technology which would have taken them a decade or more to develop on their own.

KILO, INDIA

GENERAL SPECIFICATIONS

Country: India

Class: KILO
Type: 877EM

Bought: 8
Building: 0
In service: 8

Displacement:
surfaced: 2,325 t
submerged: 3,076 t

Dimensions
Length: 72.6 m (238.2 ft)
Beam: 9.9 m (32.5 ft)
Draught: 6.6 m (21.7 ft)

Speed:
surfaced: 10 kts
snorting: 9 kts
submerged: 17 kts
Range:
snorting: 6,000 n miles at 7 kts
submerged: 400 n miles at 3 kts

Diving depth:
normal: 240 m
max: 300 m (985 ft)

Complement: 52 (13 officers)

SUBMARINES

SINDHUGHOSH (S 55)
Builder Sudomekh, Leningrad
Commissioned 30 Apr 1986

SINDHUDHVAJ (S 56)
Builder Sudomekh, Leningrad
Commissioned 12 Jun 1987

SINDHURAJ (S 57)
Builder Sudomekh, Leningrad
Commissioned 20 Oct 1987

SINDHUVIR (S 58)
Builder Sudomekh, Leningrad
Commissioned 26 Aug 1988

SINDHURATNA (S 59)
Builder Sudomekh, Leningrad
Commissioned 16 Feb 1989

SINDHUKESARI (S 60)
Builder Sudomekh, Leningrad
Commissioned 10 Mar 1989

SINDHUKIRI (S 61)
Builder Sudomekh, Leningrad
Commissioned 4 Mar 1990

SINDHUVIJAY (S 62)
Builder Sudomekh, Leningrad
Commissioned 8 Mar 1991

Sindhukesari *(S 60)* (H & L van Ginderen Collection)

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Strela 2 (NATO = SA-N-5)

Launcher and missiles are stored in a watertight container at the bottom of the SAM well, located between the snorkel and the radio antenna masts in the sail. The SAM crew consists of the launcher operator and the loader who extracts new rounds from the missile container.

Specifications

Russian designation: Strela 2
NATO designation: SA-N-5 (Grail)
No of missiles carried: 8
Length: 1.45 m
Diameter: 7 cm
Weight: 9.97 kg
Speed: Mach 1.7
Range: 2.6 n miles (5.5 km)
Altitude: 18-4,500 m

Manufacturer/Contractor

Fakel Machine Building and Design Enterprise, Khimky-5, Moscow, Russia.

TUBES

Six 533 mm (21 in) torpedo tubes; compressed air launch.
Total weapon load, 18 (six in the tubes, 12 in racks).

TORPEDOES

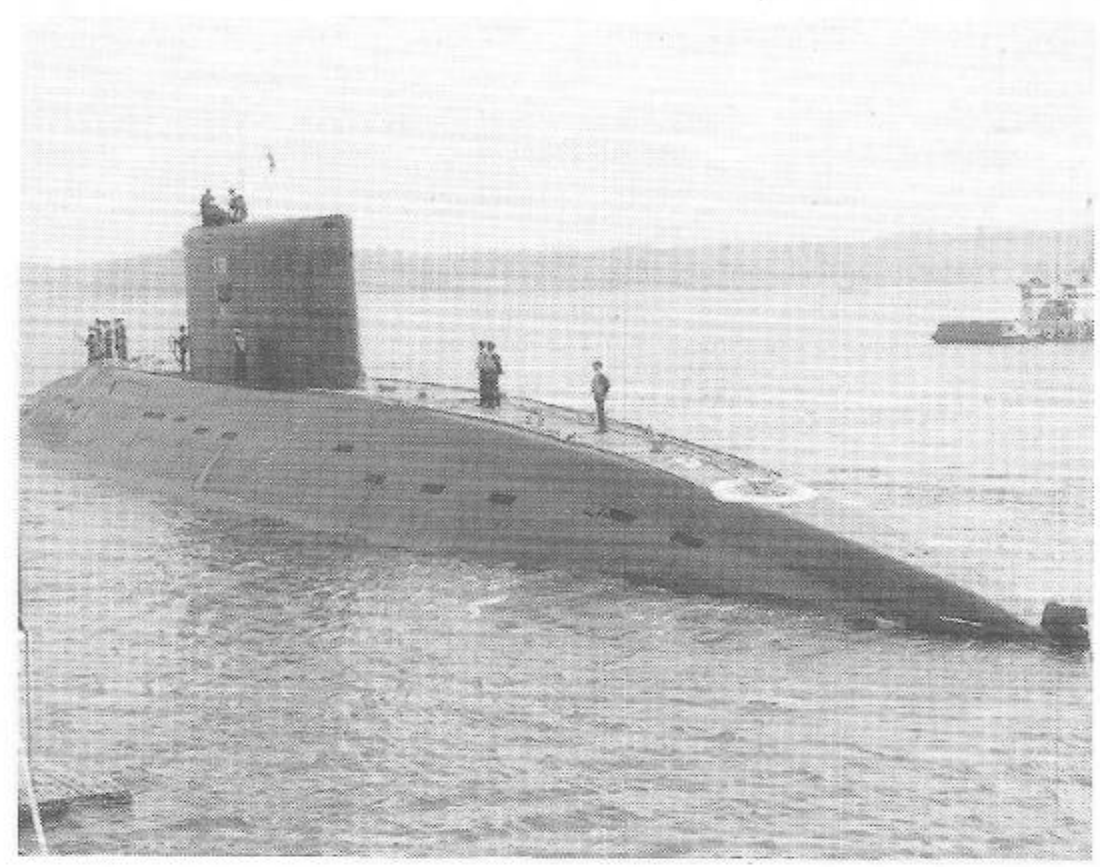
TEST-71ME

Six torpedoes can be TEST-71ME wire-guided torpedoes launched from Nos 1 and 2 tubes only. Other torpedoes include Types 53-65KE, 53-56B, 53BA and CET-53ME.

MINES

Up to 24 AM-1 mines can be carried instead of torpedoes, but there is no confirmation that India has bought such weapons.

Sindhuvir *(S 58). The small vertical device aft contains the navigation light and is necessary because there is no upper vertical rudder* (H & L van Ginderen Collection)



Sindhuvijay *(S 62)* (H & L van Ginderen Collection)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

MP П -25 Э

MPП-25 Э gives warning of airborne and seaborne radar emitters.

COMMAND AND CONTROL SYSTEMS

RADAR

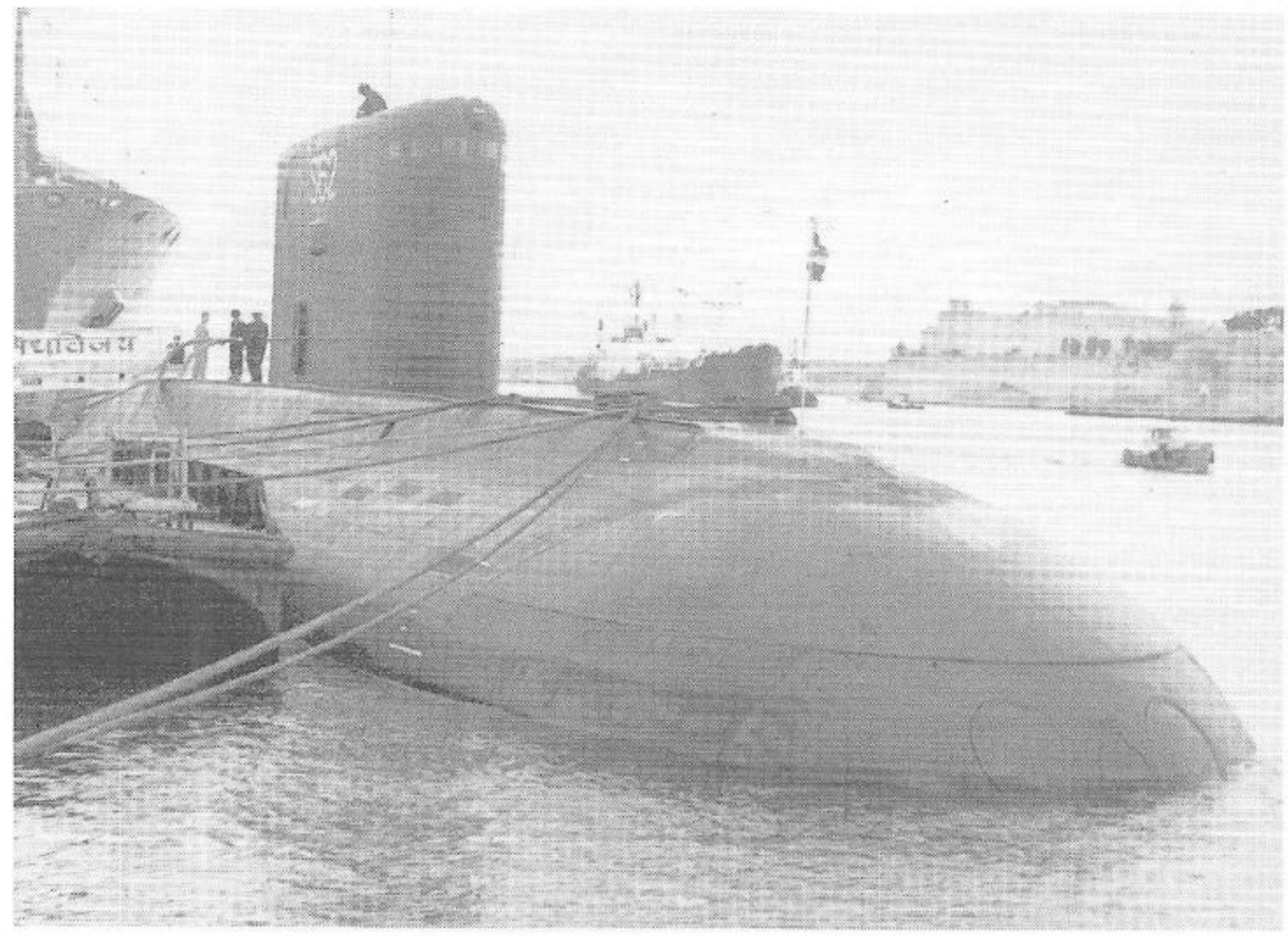
MPK-50 Э

MPK-50 Э I-band, surface- and air-search and navigation radar.

SONARS

M Г K-400

The MГK-400 active/passive sonar array is located in the bow, with a large number of transducers mounted in a titanium cylinder. Typical detection performance in the passive mode is 16 to 20 km against submerged targets and 60 to 80 km against surface targets. In the active mode the system can provide range data on submerged targets at ranges of 16 to 20 km, and it can also be used for long-range (60 to 80 km) and short-range (20 to 25 km) telephone or telegraph communications



Sindhuvijay *(S 62)*
(H & L van Ginderen Collection)

with other similarly equipped submarines in either telephone or telegraph modes. On the surface, the sonar can be reached through a tunnel in the bow casing, and individual transducers can be easily replaced. Neither flank nor towed arrays are fitted, Rubin stating that the performance of the МГК-400 fully meets the requirements of the Type 877's role.

МГ-519
МГ-519 is a hydroacoustic mine detection sonar.

МГ-553
МГ-553 measures sound velocity in water.

МГ-512
МГ-512 detects propeller cavitation.

PROPULSION

Specifications
System: Diesel-electric
Diesel generators: 2—4-stroke, 6-cylinder, in-line, Model 4-2AA-42M engines with gas-turbine supercharging, each giving 1,500 kW at 700 rpm. Two Type ПГ-142 generators, rated at 1,000 kW each
Electric motor: 1 Type ПГ-141; 4,050 kW (5,500 hp); 485±5 rpm; 430-360 V
Cruise motor: 1 Type ПГ-140; 139 kW (190 hp); 150 rpm; 320-190 V
Reserve propulsion motors: 2 Type ПГ-168; 75 kW (102 hp); 650±10 rpm; 320-200 V
Battery: 2 groups, each of 120 cells, rated at 100 A at 9,700 kW h capacity (cells are licence-produced in India)
Shafts: 1
Propeller: 1—6-bladed propeller

FURTHER INFORMATION

PROGRAMME

The 'Kilo' class was launched in the Soviet Navy in 1979 and India was the first export customer, placing an original order for six. India was, however, acquiring Type 209 ('Sishumar' class) submarines at the same time, two to be constructed in Germany and four in Bombay, India. That programme was, however, subject to repeated delays as a result of which the number of boats to be built in India was cut back to two. To balance this, the 1983 order for six 'Kilo' class was increased to ten, although it was later cut back to eight. All these were constructed in Russia, although there have been several reports that the Indians are seeking a licence to build the class in Mazagon.

MODERNISATION

An engine change is being considered. Battery cooling has been improved.

OPERATIONAL

Based at Vishakapatnam and Bombay.

KILO, IRAN

GENERAL SPECIFICATIONS

Country: Iran

Class: KILO
Type: 877 EKM

Bought: 3
Awaiting delivery: 1
In service: 2

Displacement:
surfaced: 2,356 t
submerged: 3,076 t dived

Dimensions
Length: 73.8 m (242.1 ft)
Beam: 9.9 m (32.5 ft)
Draught: 6.6 m (21.7 ft)

Speed:
surfaced: 10 kts
snorting: 9 kts
submerged: 17 kts
Diving depth: 240 m (787 ft) normal

Range:
snorting: 6,000 n miles at 7 kts
submerged: 400 n miles at 3 kts

Complement: 53 (12 officers)

SUBMARINES

TAREQ (901)	
Builder	Admiralty Yard, St Petersburg, Russia
Laid down	1988
Launched	1991
Commissioned	21 Nov 1992

NOOR (902)	
Builder	Admiralty Yard, St Petersburg, Russia
Laid down	1989
Launched	1992
Commissioned	6 Jun 1993

— (903)	
Builder	Admiralty Yard, St Petersburg, Russia
Laid down	1990
Launched	1993
Commissioned	—

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Strela 2 (NATO = SA-N-5)
Launcher and missiles are stored in a watertight container at the bottom of the SAM well, located between the snorkel and the radio antenna masts in the sail. The SAM crew consists of the launcher operator and the loader who extracts new rounds from the missile container.

Specifications
Russian designation: Strela 2
NATO designation: SA-N-5 (Grail)
Carried in: Type 877
No of missiles carried: 8
Length: 1.45 m
Diameter: 7 cm
Weight: 9.97 kg
Speed: Mach 1.7
Range: 2.6 n miles (5.5 km)
Altitude: 18-4,500 m

Manufacturer/Contractor
Fakel Machine Building and Design Enterprise, Khimky-5, Moscow, Russia.

TUBES

Six 533 mm (21 in) torpedo tubes; compressed air launch.
Total weapon load, 18 (six in the tubes, 12 in racks).

TORPEDOES

TEST-71ME
Six torpedoes can be TEST-71ME wire-guided torpedoes launched from Nos 1 and 2 tubes only. Other torpedoes include Types 53-65KE, 53-56B, 53BA and CET-53ME.

MINES

Up to 24 AM-1 mines can be carried instead of torpedoes, but there is no confirmation that Iran has bought such weapons.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

MP П -25 Э radar warning

MPП-25 Э (NATO = Squid Head) gives warning of airborne and seaborne radar emitters.

Direction-finding

Rumb (NATO = Quad Loop) high-frequency (HF) direction finder.

COMMAND AND CONTROL SYSTEMS

RADAR

MPK-50 Э

MPK-50 Э (NATO = Snoop Tray) I-band, surface and air search and navigation radar.

SONARS

MГK-400

The MГK-400 (NATO = Shark Teeth) active/passive sonar array is located in the bow, with a large number of transducers mounted in a titanium cylinder. Typical detection performance in the passive mode is 16 to 20 km against submerged targets and 60 to 80 km against surface targets. In the active mode the system can provide range data on submerged targets at ranges of 16 to 20 km, and it can also be used for long-range (60 to 80 km) and short-range (20 to 25 km) telephone or telegraph communications with other similarly equipped submarines in either telephone or telegraph modes. On the surface, the sonar can be reached through a tunnel in the bow casing, and individual transducers can be easily replaced. Neither flank nor towed arrays are fitted, Rubin stating that the performance of the MГK-400 fully meets the requirements of the Type 636's role.

MГ -519

MГ-519 is a hydroacoustic mine detection sonar.

MГ -553

MГ-553 measures sound velocity in water.

MГ -512

MГ-512 detects propeller cavitation.

PROPULSION

Specifications

System: Diesel-electric

Diesel generators: 2—4-stroke, 6-cylinder, in-line, Model 42AA42M engines with gas-turbine supercharging, each giving 1,500 kW at 700 rpm; 2 Type ПГ-142 generators, rated at 1,000 kW each

Electric motor: 1 Type ПГ-141; 4,050 kW (5,500 hp); 485±5 rpm; 430-360 V

Cruise motor: 1 Type ПГ-140; 139 kW (190 hp); 150 rpm; 320-190 V

Reserve propulsion motors: 2 Type ПГ-168; 75 kW (102 hp); 650±10 rpm; 320-200 V

Battery: 2 groups, each of 120 Type 446 cells, rated at 100 A at 9,700 kW h capacity

FURTHER INFORMATION

PROGRAMME

The first two attempts by the Iranian Navy to obtain submarines were unsuccessful. Three 'Tang' class boats were being prepared for transfer when the revolution and the subsequent cooling in relations led the United States to cancel the deal in 1979. An order for six Type 209s from Germany was cancelled in 1979 by the Iranians. The third attempt, however, proved more successful when they signed a contract with Russia in 1988 for the supply of three Kilos.

The first to be transferred sailed from the Baltic in October 1992 flying the Russian flag and with a predominantly Russian crew. The second sailed in June 1993. The third boat was expected to be delivered in 1995 but delivery has apparently been delayed by funding problems.

OPERATIONAL

The two submarines so far delivered are based at Bandar Abbas but it is planned that they will move to Shah Bahar, a major naval facility outside the Persian Gulf on the northern shore of the Gulf of Oman. There is evidence of some co-operation with India, which also operates Kilos, with the Indian Navy providing some training assistance. It is also reported that problems with battery cooling are being resolved with Indian help.

OPINION

The northern Gulf of Oman and the few deep water parts of the Persian Gulf are notoriously difficult areas for anti-submarine warfare. These submarines will be vulnerable to attack when alongside in harbour but could pose a severe threat to merchant shipping either with torpedoes or mines.

KILO, POLAND

GENERAL SPECIFICATIONS

Country: Poland

Class: KILO
Type: 877E

Bought: 1
In service: 1

Displacement:
surfaced: 2,460 t
submerged: 3,180 t

Dimensions
Length: 72.6 m (238.19 ft)
Beam: 9.9 m (32.5 ft)
Draught: 6.5 m (21.32 ft)

Speed:
surface: 10 kts
snorting: 9 kts
submerged: 17 kts
Diving depth:
normal: 240 m (787 ft)
max: 300 m (984 ft)

Range:
snorting: 6,000 n miles at 7 kts
submerged: 400 n miles at 3 kts

Complement: 52 (13 officers)

SUBMARINES

ORZEL (291)
Builder Admiralty Yard, St Petersburg, Russia
Commissioned 21 Jun 1986

WEAPONS SYSTEMS

TUBES

Six 533 mm (21 in) tubes; compressed air discharge. Total weapon load, 18.

TORPEDOES

TEST-71ME

A maximum of six can be TEST-71, wire-guided torpedoes, which can be launched from Nos 1 and 2 tubes only.

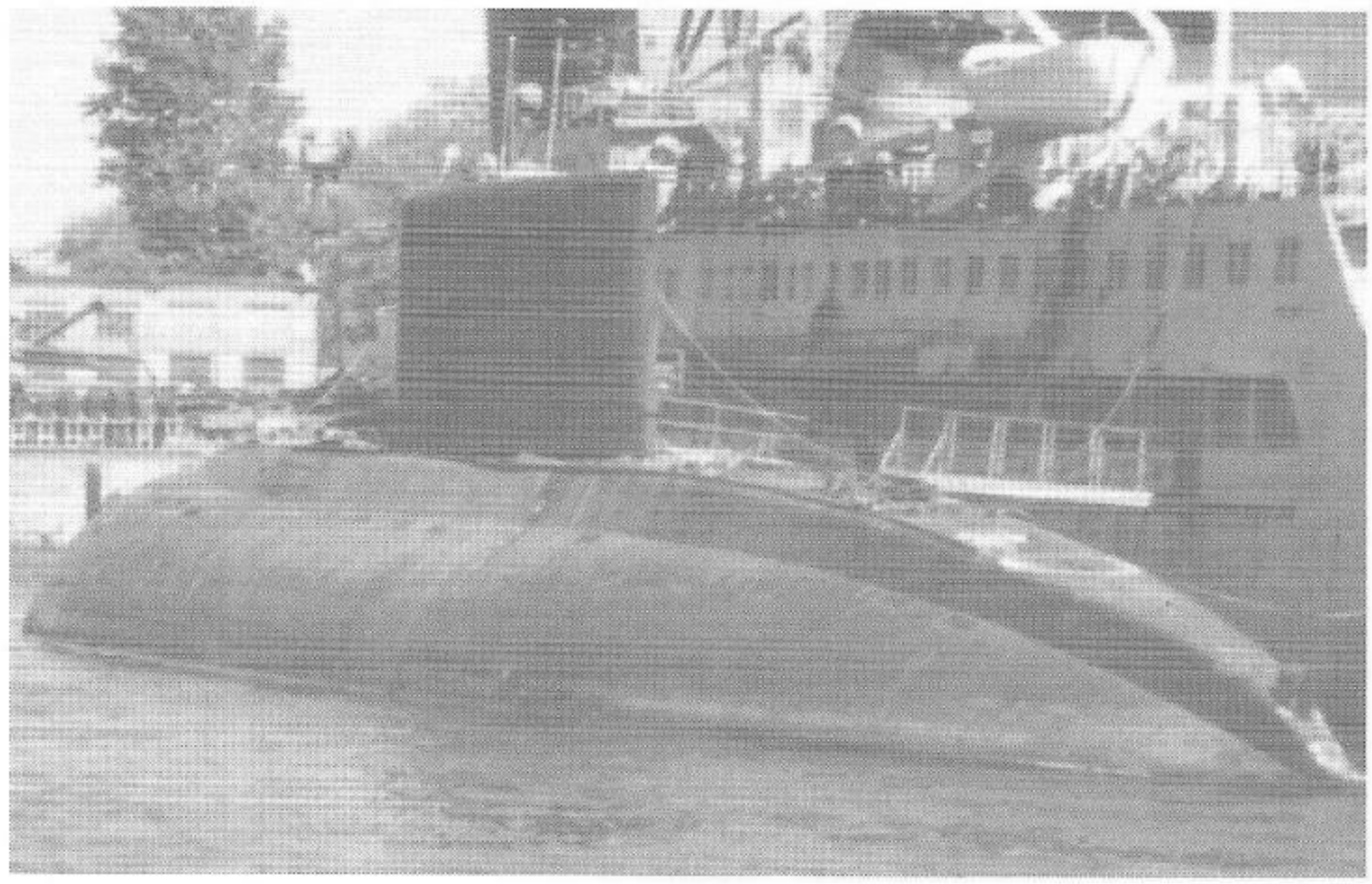
TEST-71 is an anti-submarine torpedo, using active/passive homing to 8.1 n miles (15 km) at 40 knots, and has a 205 kg warhead.

Type 53-65KE

The other type carried by *Orzel* is Type 53-65, an anti-surface torpedo, using passive/wake homing to 13.5 n miles (25 km) at 50 knots. It has a 300 kg warhead.

MINES

24 in lieu of torpedoes.



Polish Kilo, Orzel *(291) in 1995*

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Ankier (NATO = Brick Group); radar warning.

Direction-finding

Rumb (NATO = Quad Loop) high-frequency (HF) direction finder.

COMMAND AND CONTROL SYSTEMS

RADAR

MPK-50 Э

MPK-50 Э I-band, surface- and air-search and navigation radar. (NATO =Snoop Tray).

SONARS

MГK-400

The MГK-400 (NATO = Shark Teeth) active/passive sonar array is located in the bow, with a large number of transducers mounted in a titanium cylinder. Typical detection performance in the passive mode is 16 to 20 km against submerged targets and 60 to 80 km against surface targets. In the active mode the system can provide range data on submerged targets at ranges of 16 to 20 km, and it can also be used for long-range (60 to 80 km) and short-range (20 to 25 km) telephone or telegraph communications with other similarly equipped submarines in either telephone or telegraph modes. On the surface, the sonar can be reached through a tunnel in the bow casing, and individual transducers can be easily replaced. Neither flank nor towed arrays are fitted, Rubin stating that the performance of the MГK-400 fully meets the requirements of the Type 636's role.

MГ-519

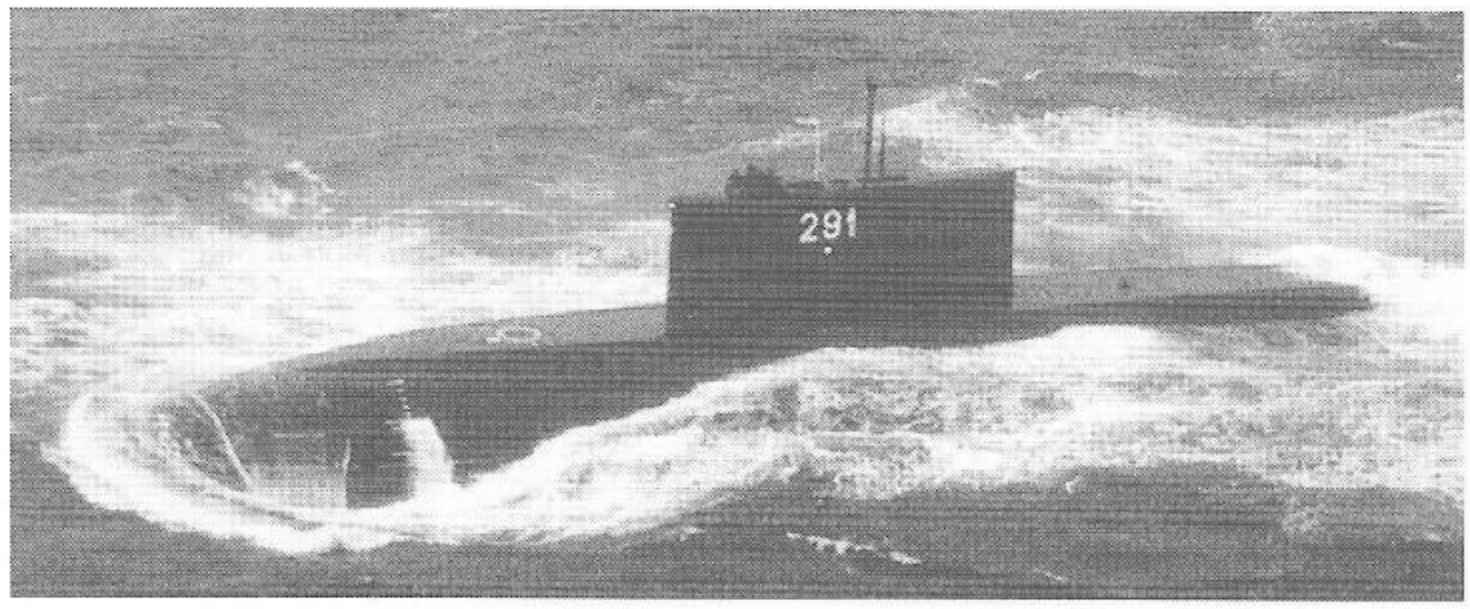
MГ-519 is a hydroacoustic mine detection sonar.

MГ-553

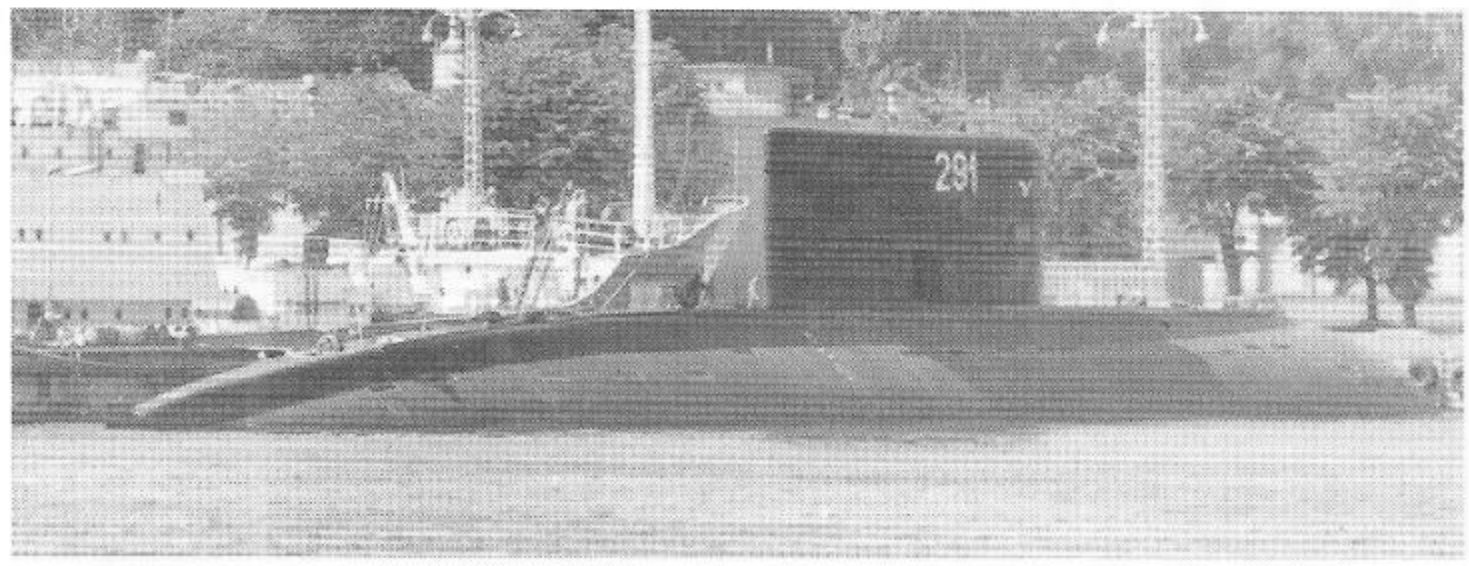
MГ-553 measures sound velocity in water.

MГ-512

MГ-512 detects propeller cavitation.



Orzel *(291) at sea in the Baltic. The Polish Navy continues to operate this submarine, even though it considers it to be too large for Baltic operations*



Orzel *(291) was obtained as part of a barter deal for amphibious vessels supplied to the (then) USSR* (H & L van Ginderen Collection)

PROPULSION

Specifications

System: Diesel-electric

Main Machinery: 2—42DL42M diesels; 1,250 kW (1,700 hp(m)); 2 generators

Electric motor: PG-141 motor; 4.05 MW (5,500 hp(m))

Shaft: 1

Auxiliary motors: 2 auxiliary motors; 150 kW (204 hp(m))

Economic speed motor: 1—95 kW (130 hp)

FURTHER INFORMATION

PROGRAMME

The transfer to Poland was the second export order for the class (the first was to India) and was part of an exchange deal with the (then) USSR for Polish-built amphibious ships. The Polish Navy has, however, found the Kilo to be too large for Baltic operations and requested that later transfers should be of the 'Foxtrot' class.

OPERATIONAL

Orzel is part of the 3rd Submarine Division based at Gdynia.

Note
Some of the figures given in the specifications differ slightly from those in other entries of the class, but are from a reputable Polish source

KILO, ROMANIA

GENERAL SPECIFICATIONS

Country: Romania

Class: KILO
Type: 877E

Bought: 1
Building: 0
In service: 1

Displacement:
surfaced: 2,325 t
submerged: 3,076 t

Dimensions
Length: 72.6 m (238.2 ft)
Beam: 10 m (32.8 ft)
Draught: 6.6 m (21.7 ft)

Speed:
surfaced: 10 kts
snorting: 9 kts
submerged: 20 kts
Diving depth: 240 m (785 ft)

Range:
surfaced: 6,000 n miles at 7 kts
submerged: 400 n miles at 3 kts

Complement: 52 (12 officers)

SUBMARINES

DELFINUL (521)

WEAPONS SYSTEMS

TUBES

Six 533 mm (21 in) tubes; compressed air discharge. Total weapon load, 18.

TORPEDOES

TEST-71ME
A maximum of six can be TEST-71, wire-guided torpedoes, which can be launched from Nos 1 and 2 tubes only. TEST-71 is an anti-submarine torpedo, using active/passive homing to 8.1 n miles (15 km) at 40 knots, and has a 205 kg warhead.

Type 53-65KE
The other type carried by *Delfinul* is the Type 53-65 anti-surface torpedo, using passive/wake homing to 13.5 n miles (25 km) at 50 knots. It has a 300 kg warhead.

MINES

24 can be carried in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

MP П -25 Э radar warning
MPП-25 Э (NATO = Squid Head) gives warning of airborne and seaborne radar emitters.

Direction-finding
Rumb (NATO = Quad Loop) high-frequency (HF) direction finder.

COMMAND AND CONTROL SYSTEMS

RADAR

MPK-50 Э
MPK-50 Э (NATO = Snoop Tray) I-band, surface and air search and navigation radar.

SONARS

MГK-400
The MГK-400 (NATO = Shark Teeth) active/passive sonar array is located in the bow, with a large number of transducers mounted in a titanium cylinder. Typical detection performance in the passive mode is 16 to 20 km against submerged targets and 60 to 80 km against surface targets. In the active mode the system can provide range data on submerged targets at ranges of 16 to 20 km, and it can also be used for long-range (60 to 80 km) and short-range (20 to 25 km) telephone or telegraph communications with other similarly equipped submarines in either telephone or telegraph modes. On the surface, the sonar can be reached through a tunnel in the bow casing, and individual transducers can be easily replaced. Neither flank nor towed arrays are fitted, Rubin stating that the performance of the MГK-400 fully meets the requirements of the Type 636's role.

MГ-519
MГ-519 is a hydroacoustic mine detection sonar.

MГ-553
MГ-553 measures sound velocity in water.

MГ-512
MГ-512 detects propeller cavitation.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2—42DL42M diesels; 1,250 kW (1,700 hp(m)); 2 generators

Electric motor: 1 PG-141 motor; 4.05 MW (5,500 hp(m))
Shaft: 1

Auxiliary motors: 2 auxiliary motors; 150 kW (204 hp(m))
Economic speed motor: 1—95 kW (130 hp)

FURTHER INFORMATION

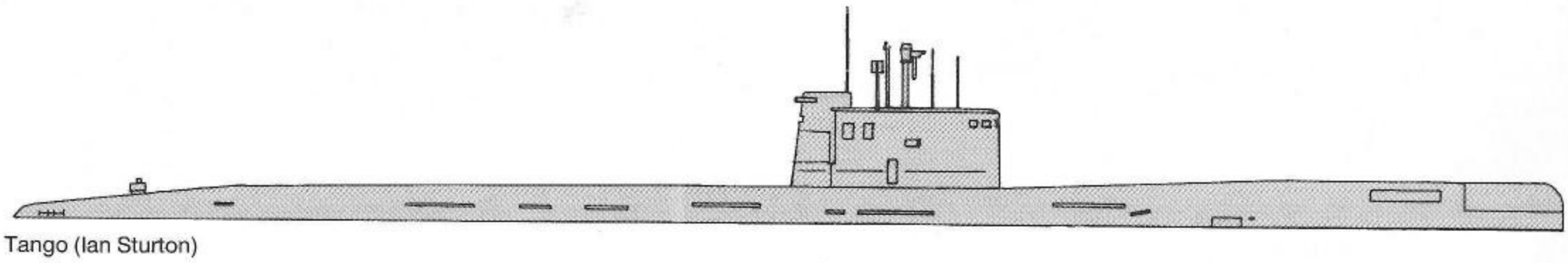
PROGRAMME

The Romanian Navy has operated submarines intermittently for many years. Two Romanian-designed and built boats were returned by the USSR after the Second World War but were retired in the 1950s. There was then a gap until four elderly Soviet 'MV' class submarines were acquired in 1957 and served for ten years. There was then another gap until the 'Kilo' class submarine, *Delfinul*, was acquired in December 1986 at a time when the Romanian Navy was being expanded and a number of major surface units were joining the fleet. A second Kilo was planned but financial reality intervened and the contract was cancelled.

OPERATIONAL

Delfinul is operational and is based at Constantia.

TANGO



Tango (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia

Class: TANGO (SOM)
Type: 641B

Built: 18
In service: 18

Displacement:
surfaced: 3,000 t
submerged: 3,800 t

Dimensions
Length: 91 m (298.6 ft)
Beam: 9.1 m (29.9 ft)
Draught: 7.2 m (23.6 ft)

Speed:
surfaced: 13 kts
submerged: 16 kts
Diving depth: 250 m (820 ft)
Range, submerged: 500 n miles at 3 kts

Complement: 62 (12 officers)

SUBMARINES

Total built 18
Built 1972-1981

WEAPONS SYSTEMS

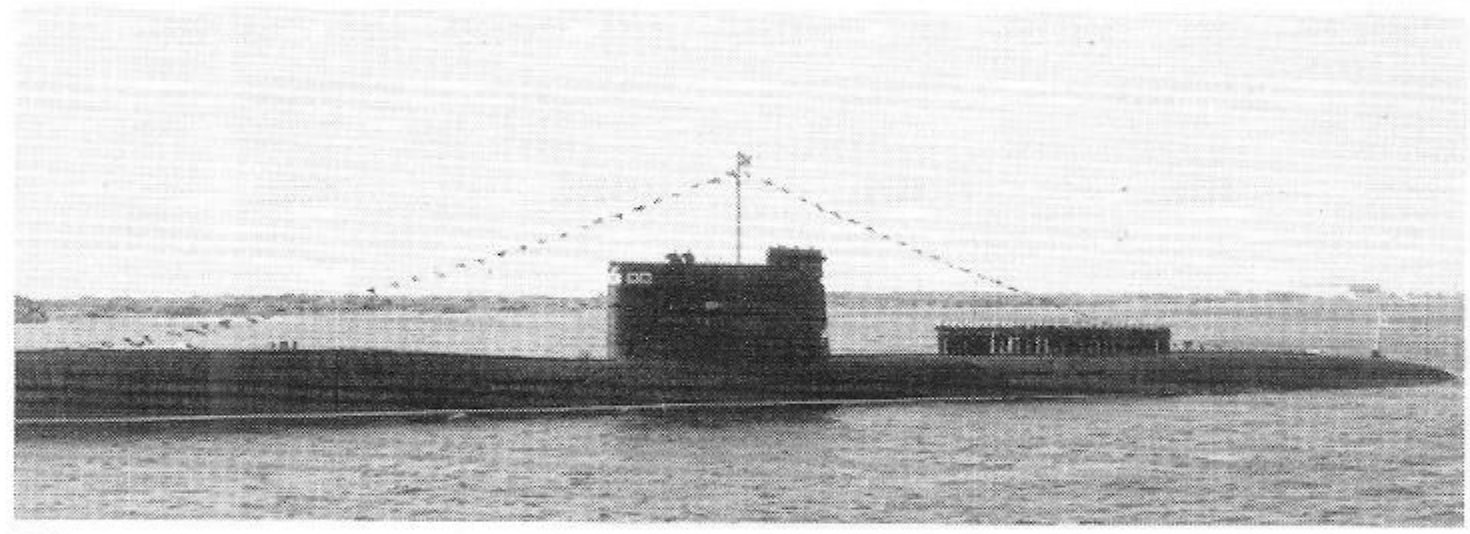
TUBES

Six 533 mm (21 in) tubes; bow (note: there are no stern tubes).
Total weapons carried, 18.

TORPEDOES

SS-N-15 (NATO = Starfish)

It is believed, but not yet confirmed, that the 'Tango' class carries SS-N-15, tube-launched, ASW missiles. This weapon is similar in shape to SUBROC, having a long, slim cylinder with small, retractable fins and a booster rocket at the end. SS-N-15 is associated with a low-frequency, bow-mounted, active/passive sonar system with 6 m diameter array (NATO = Shark Teeth). The weapon is loaded into a standard 533 mm torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the submarine when the rocket motor ignites and drives it to the surface and on into the atmosphere. It flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-15 payload is either a 200 kT nuclear depth charge or a Type 40 lightweight torpedo although, it should be noted, that under current international agreements, nuclear warheads would not be carried at sea; the capability, however, remains.



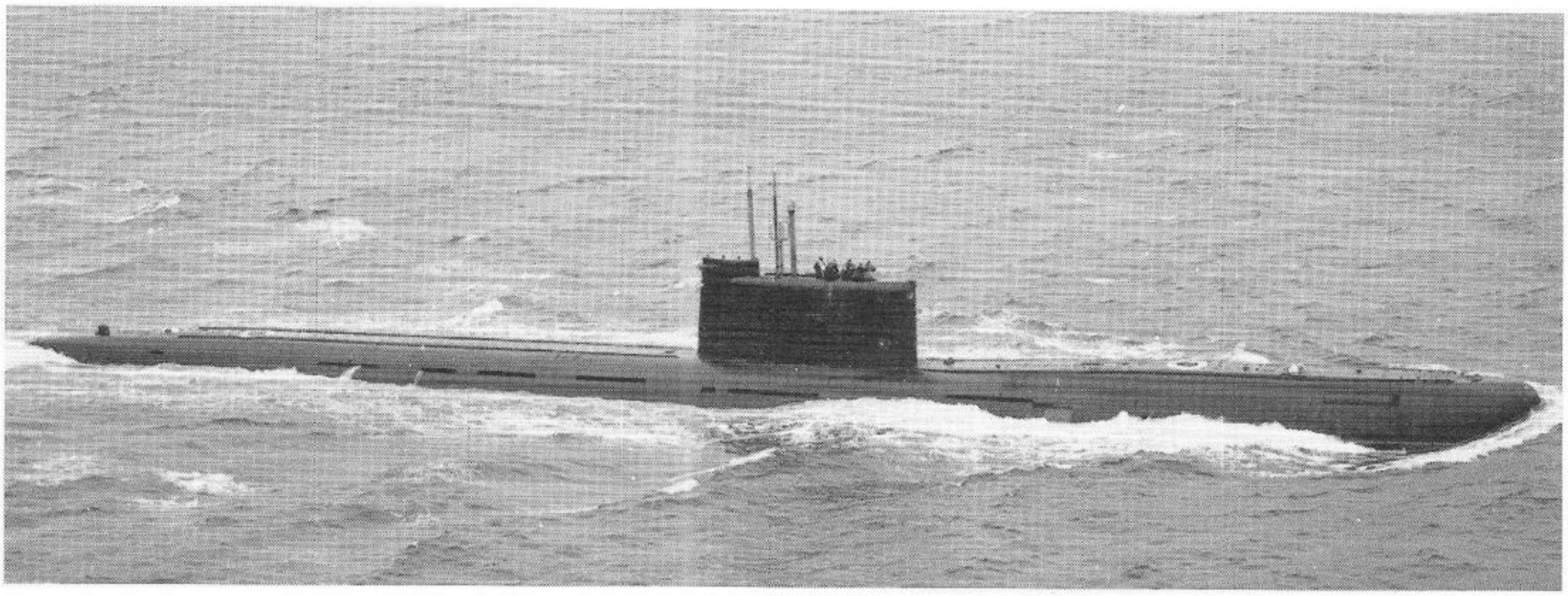
This picture shows the raised bow very clearly, but the use to which this extra volume is put has never been explained

Specifications
Length: 6.5 m (21.33 ft)
Diameter: 533 mm (21 in)
Wing span: n/k
Weight: 1,800 kg (3,968 lb)
Range: 24-27 n miles (45-50 km)
Speed: n/k
Guidance: Inertial

The Tangos also carry a variety of Russian torpedoes.

MINES

24 mines can be carried in lieu of torpedoes.



'Tango' class. These submarines have been in service since the early 1970s but have been opened for inspection by foreign experts

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Squid Head or Brick Group

Squid Head and Brick Group are ESM systems, presumably used for surveillance and threat warning and it appears that one or other is installed.

Quad Loop

Quad Loop is a DF antenna.

COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Tray

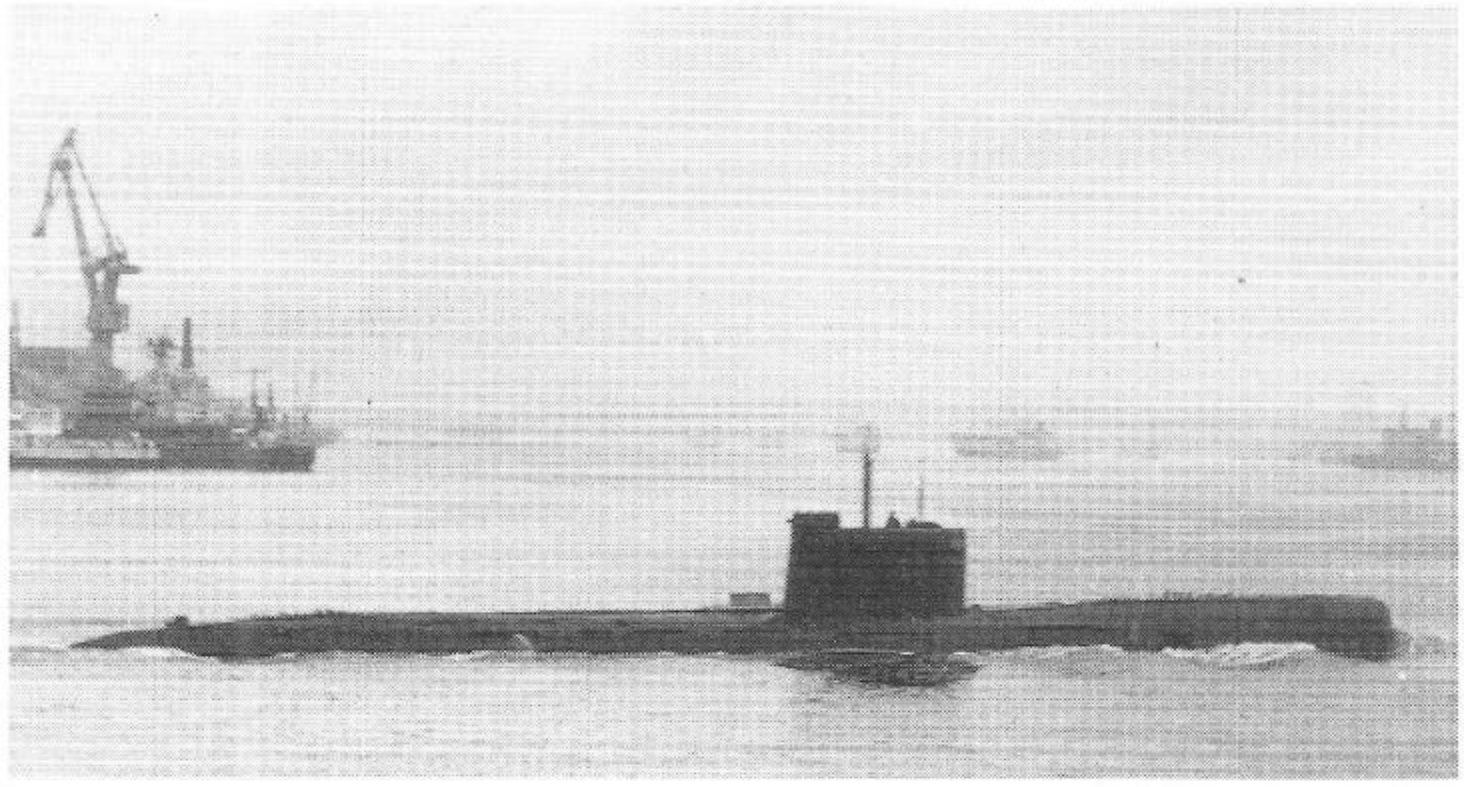
Snoop Tray is an I-band surface search radar of Soviet (Russian) origin. It has a rectangular and only slightly curved antenna.

SONARS

The 'Tango' class has two large sonar arrays forward. One is a large diameter bow dome (probably Shark Teeth) but there is also a large array mounted above the torpedo tubes. In addition, at least one of the class has been fitted with a tube above the stern from which a VDS is launched and recovered.

Shark Teeth

Shark Teeth is a hull-mounted, medium-frequency, passive/active, search and attack sonar. It is usually associated with the SS-N-15 missile



Tango departs Murmansk on patrol in 1993 (H & L van Ginderen Collection)

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 2 Type 2D-42 diesels, each 1.4 MW, plus one diesel 1.8 MW, total 4.6 MW (6,256 hp (m))
Electric motors: 2 motors, each 1 MW, plus 1 motor 1.8 MW; total 3.8 MW (5,168 hp (m))
Shafts: 3

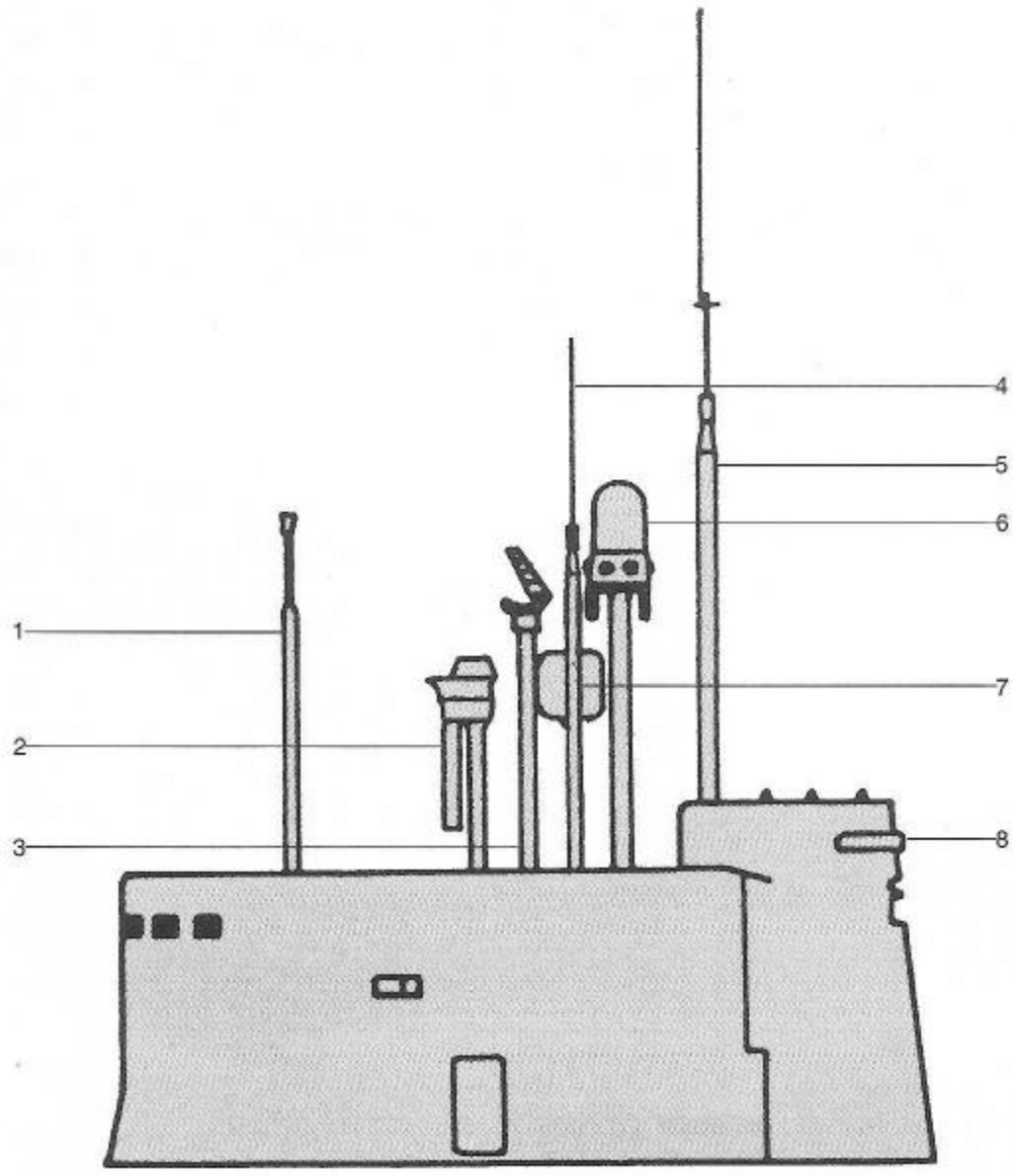
FURTHER INFORMATION

PROGRAMME

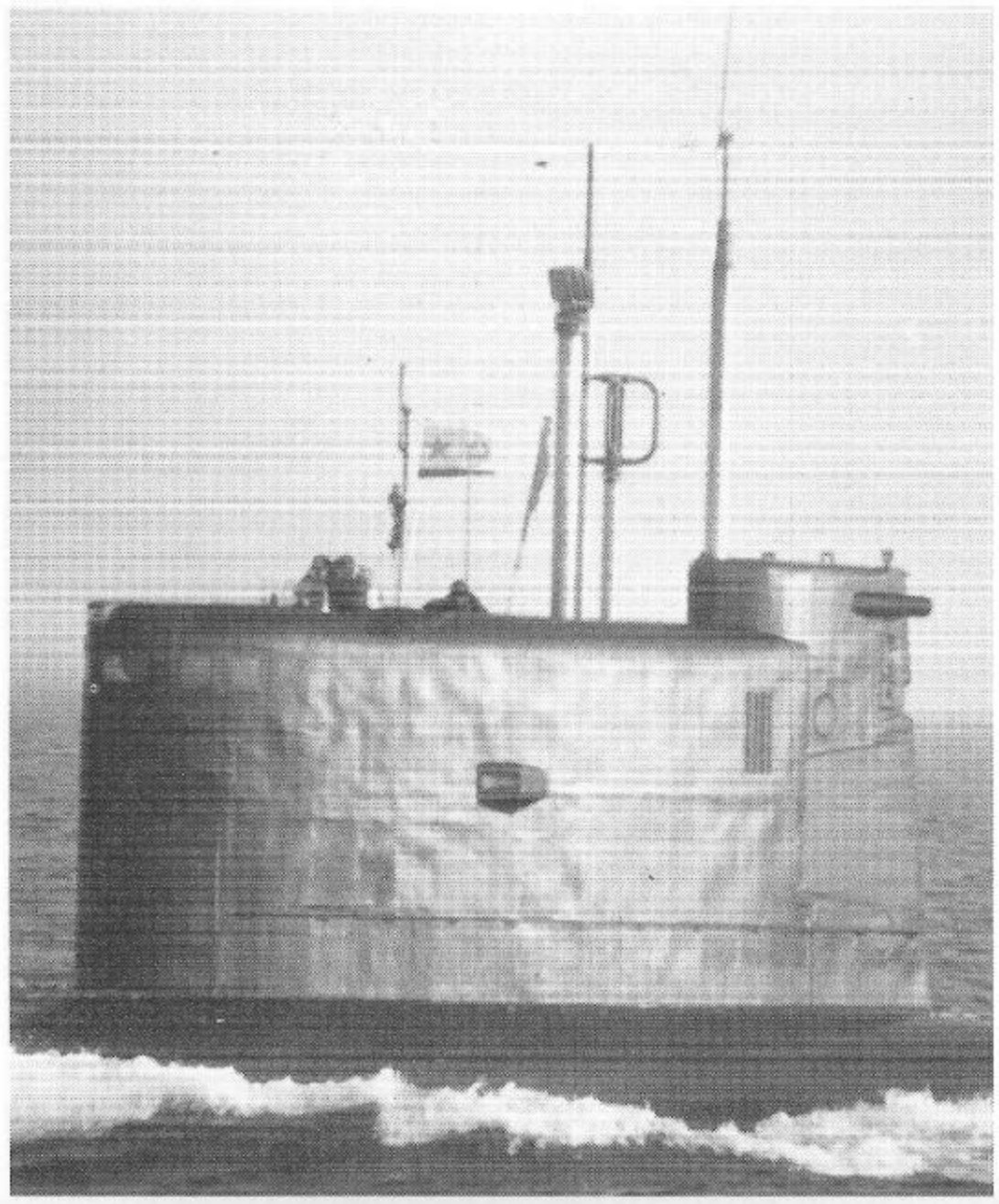
This class was first seen by Western observers at the Sevastopol Review in July 1973 and caused some surprise, as it was thought at that time that the Soviet Navy was concentrating on nuclear designs. The building rate rose to two a year at Gorky (Nizhny Novgorod) and the programme finished in 1982. One Northern Fleet unit was fitted with a towed array stern tube and a reel mounted in the casing forward of the fin in 1992 and is referred to as a Modified Tango.

DESIGN

This was the last Russian submarine design to have the traditional long, thin hull and twin propellers, although it did not have any stern torpedo tubes. Nevertheless it represented a major advance over the Foxtrot design,



A sketch of the Tango's sail-mounted sensors
1 *Attack periscope* **2** *Snort tube* **3** *Snoop Tray radar* **4** *VHF/UHF mast (starboard side)* **5** *HF radio mast* **6** *Brick Pulp ESM array* **7** *Quad Loop DF array (port side)* **8** *Diesel exhaust*

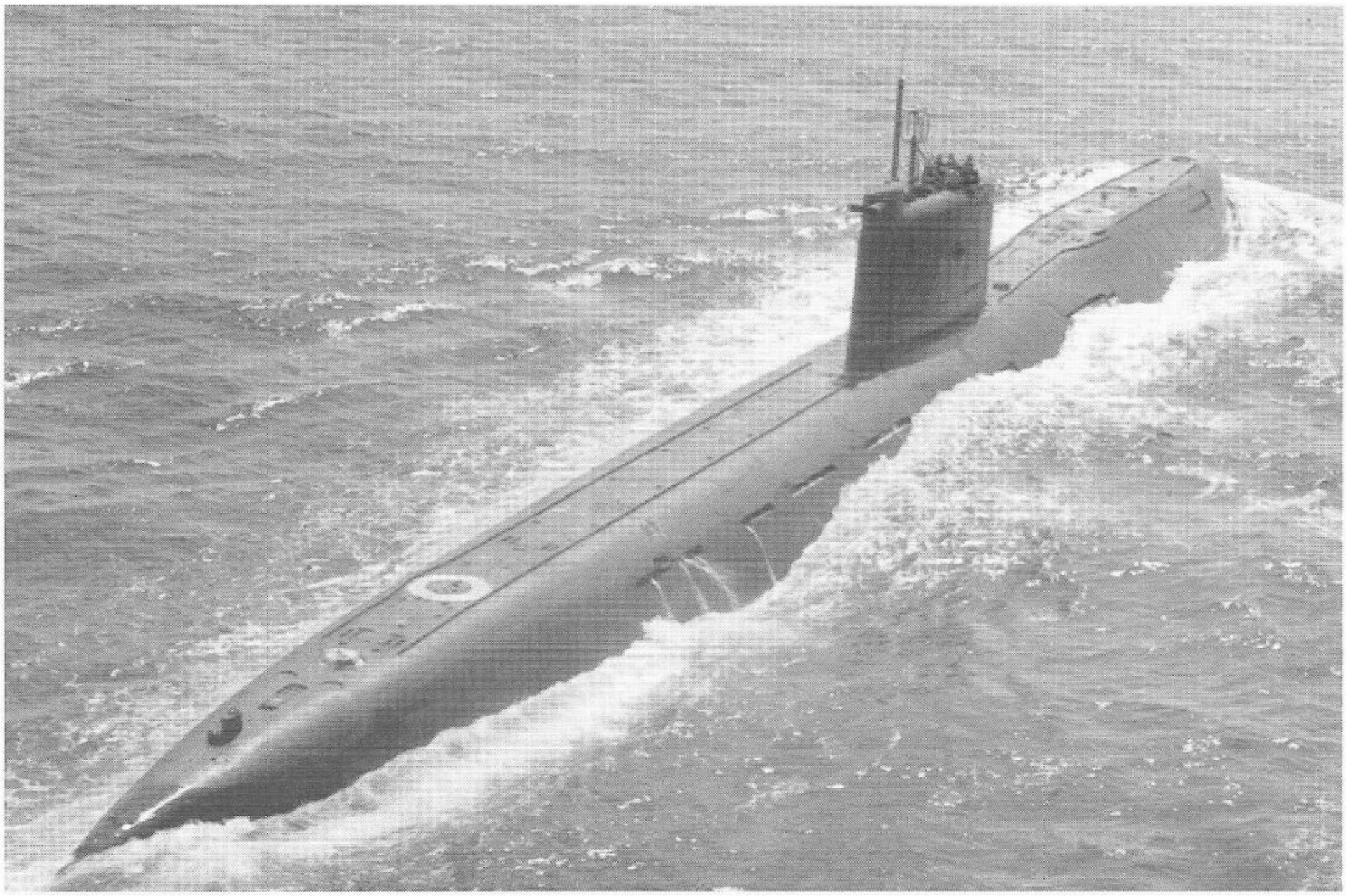


with a much more streamlined hull and a considerable increase in the internal capacity, which is used to increase battery capacity and give better habitability than in the Foxtrot. The casing and fin have a continuous acoustic coating.

The proportion of officers to sailors (12:50) is markedly higher than in the 'Foxtrot' class (8:67), which suggests an increased amount of technical equipment.

OPERATIONAL

These boats were designed for long endurance operations, although whether this was to give a protracted time at sea in ASW operations in the northern seas, or to give long range for operations in distant waters has not yet been established. The type has certainly undertaken long-range deployments from its Northern Fleet bases, having been seen regularly in the Mediterranean and off the West African coast. In 1996 one was stationed in the Black Sea and all the others in the Northern Fleet, with up to five at a time usually in refit at the Russian Baltic base at Kronstadt. Some have already been paid off and no more than 16 are now in service.



'Tango' class submarine

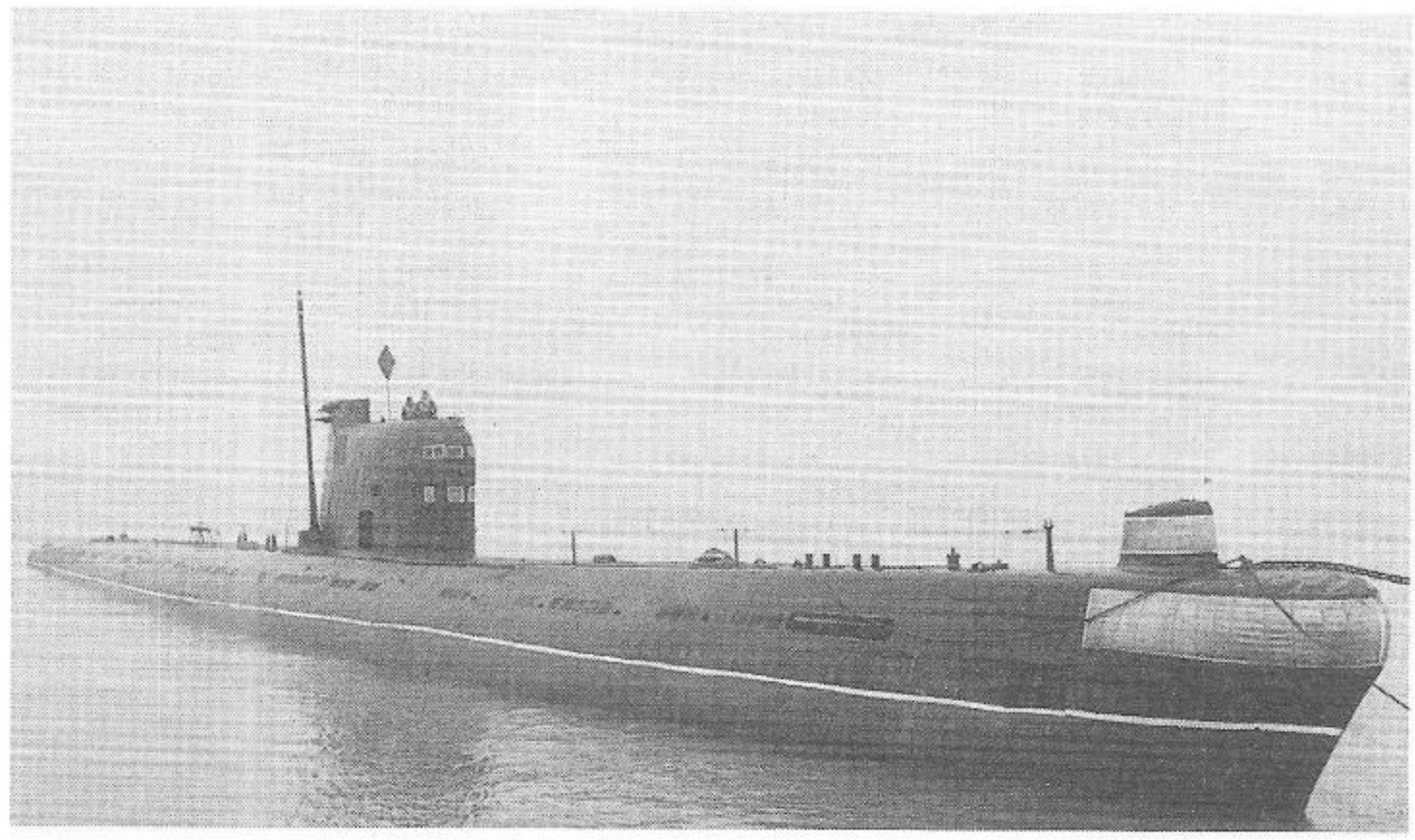
FOXTROT

OVERVIEW

The Foxtrot (Project 641), designed by the Rubin Design Bureau at St Petersburg, has been one of the more successful post-war diesel-electric submarines, with 60 built for the Soviet Navy at the Sudomekh yard between 1958 and 1971. Production then continued at a lower rate until 1984 to meet export orders from three foreign navies: Cuba — 3 (1979-84); India — 8 (1968-75); and Libya — 6 (1976-83). In addition, two were supplied from Russian Navy stocks to the Polish Navy in 1987 to 1988.

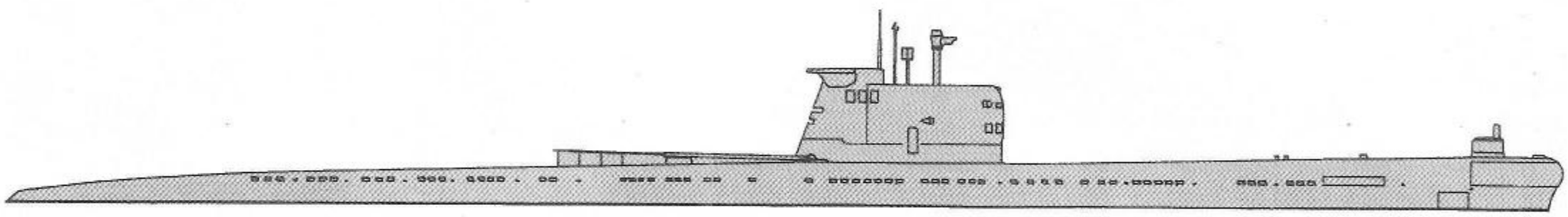
The Foxtrot was designed as a successor to the 'Zulu' class and it was originally planned to produce about 160, although, in the event, considerably fewer were completed, primarily due to the advent of nuclear-propelled attack submarines.

The most important difference between the Foxtrot and its predecessors was the sensor fit. This included Feniks, a large passive array (NATO = Trout Cheek) in the upper bow, with a prominent, silver, dielectric cover, and a small cylindrical dome atop the bow casing which housed the Herkules active sonar (NATO = Pike Jaw). In some Foxtrots there is a further tall, cylindrical dome (NATO = Fez) on top of the Herkules, which houses an underwater telephone.



Foxtrot, one of 77 built for the (then) Soviet Navy and for export (H & L van Ginderen Collection)

FOXTROT, RUSSIA



Foxtrot, Russia (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Russia

Class: FOXTROT
Type: 641

Built: 60+
In service: 2

Displacement:
surfaced: 1,952 t
submerged: 2,475 t

Dimensions
Length: 91.3 m (299.5 ft)
Beam: 7.5 m (24.6 ft)
Draught: 6 m (19.7 ft)

Speed:
surfaced: 16 kts
snorting: 9 kts
submerged: 15 kts
Diving depth: 250 m (820 ft) (reducing with age)

Range:
surfaced: 20,000 n miles at 8 kts
submerged: 380 n miles at 2 kts

Complement: 75

WEAPONS SYSTEMS

TUBES

10–533 mm (21 in); six bow, four stern tubes.
Total weapon load, 22

MINES

44 mines can be carried internally in lieu of torpedoes.

TORPEDOES

Type/Designator	Type 53-56	SET-65E	SAET-60
Role	ASV	ASW	ASV
Diameter	533 mm (21 in)	533 mm (21 in)	533 mm (21 in)
Length	7.8 m (25.6 ft)	7.8 m (25.6 ft)	7.8 m (25.6 ft)
Propulsion	Turbine	Electric	Electric
Performance	13.4 n miles (25 km) at 50 kts	8.1 n miles (15 km) at 40 kts	8.1 n miles (15 km) at 40 kts
Guidance	passive/wake	active/passive	passive
Warhead	300 kg (661 lb)	205 kg (452 lb)	400 kg (882 lb)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Stop Light
Stop Light is an ESM system for surveillance and threat warning.

COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Tray
Snoop Tray is an I-band surface search radar of Soviet (Russian) origin. It has a rectangular, and only slightly curved, antenna.

SONARS

Herkules/Feniks
Herkules was the standard Soviet active/passive search sonar for many years. Hull-mounted, it operates at medium frequencies and is usually mounted in combination with a Feniks attack sonar.

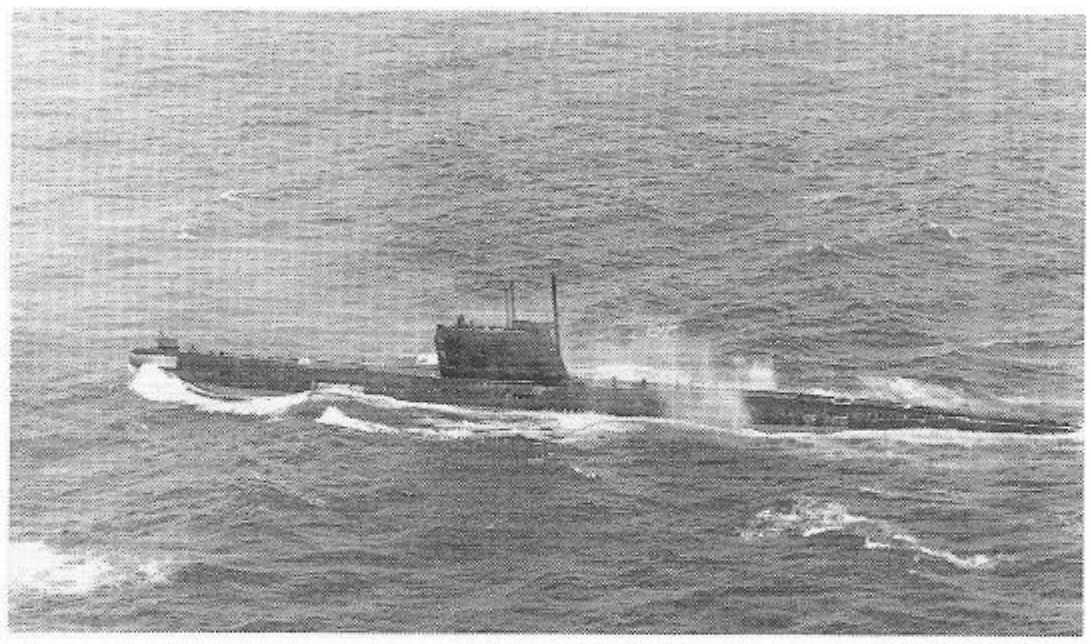
PROPULSION

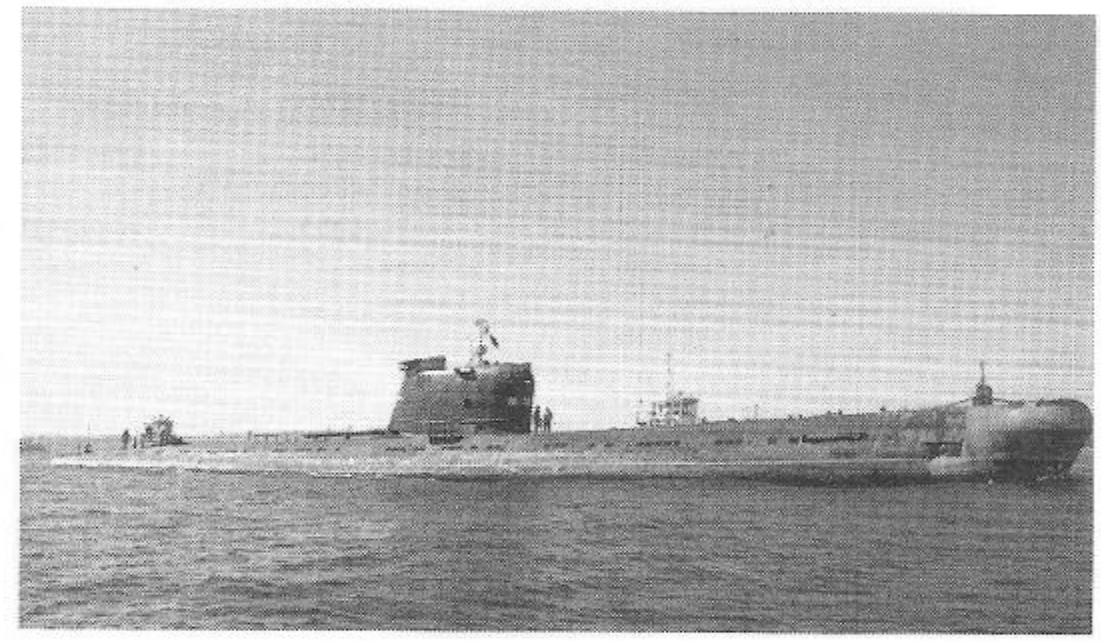
Specifications
System: Diesel-electric
Main Machinery: 3 Type 37-D diesels; 4.4 MW (6,000 hp(m))
Electric motors: 3 motors; total 3.97 MW (1 × 2,700 and 2 × 1,350 = 5,400 hp(m))
Auxiliary motor: 1—103 kW (140 hp(m))
Shafts: 3 shafts

FURTHER INFORMATION

PROGRAMME

The Russian Navy started to receive Foxtrots in 1958 and they were soon to be found in every ocean in the world. The numbers started to run down in the 1980s and by 1996 only two remained active: one in the Baltic and the other in the Pacific. Another 12 are in reserve but are unlikely to go to sea again.





*Only a few years ago 'Foxtrot' class submarines were to be found in every ocean of the world, now many are being stricken or delivered as rusting hulks for use as museum displays (*H & L van Ginderen Collection)

FOXTROT, CUBA

GENERAL SPECIFICATIONS

Country: Cuba

Class: FOXTROT
Type: 641

Bought: 3
In service: 3

Displacement:
surfaced: 1,950 t
submerged: 2,475 t

Dimensions
Length: 91.3 m (299.5 ft)
Beam: 7.5 m (24.6 ft)
Draught: 6 m (19.7 ft)

Speed:
surfaced: 16 kts
snorting: 9 kts
submerged: 15 kts

Range:
surfaced: 20,000 n miles at 8 kts
submerged: 380 n miles at 2 kts
Diving depth: 250 m (820 ft) (reducing with age)

Complement: 75 (12 officers)

SUBMARINES

725		727		729	
Builder	Sudomekh Yard, St Petersburg, Russia	**Builder**	Sudomekh Yard, St Petersburg, Russia	**Builder**	Sudomekh Yard, St Petersburg, Russia
Delivered	Feb 1979	**Delivered**	Mar 1980	**Delivered**	Feb 1984

WEAPONS SYSTEMS

TUBES

10—533 mm (21 in) tubes; six bow, four stern.
Tube-launched weapons, 22.

MINES

44 in lieu of torpedoes.

TORPEDOES

Specifications

Type/Designator	Type 53-56	SET-65E	SAET-60
Role	ASV	ASW	ASV
Diameter	533 mm (21 in)	533 mm (21 in)	533 mm (21 in)
Length	7.8 m (25.6 ft)	7.8 m (25.6 ft)	7.8 m (25.6 ft)
Propulsion	turbine	electric	electric
Performance	13.4 n miles (25 km) at 50 kts	8.1 n miles (15 km) at 40 kts	8.1 n miles (15 km) at 40 kts
Guidance	passive/wake	active/passive	passive
Warhead	300 kg (661 lb)	205 kg (452 lb)	400 kg (882 lb)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Stop Light

Stop Light is an ESM system for surveillance and threat warning.

COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Tray

Snoop Tray is an I-band surface search radar of Soviet (Russian) origin. It has a rectangular and only slightly curved antenna.

SONARS

Herkules/Feniks

Herkules was the standard Soviet active/passive search sonar for many years. Hull-mounted, it operates at medium frequencies and is usually mounted in combination with a Feniks attack sonar.

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 3 Type 37-D diesels; 4.4 MW (6,000 hp(m))
Electric motors: 3 motors; total 3.97 MW (1 × 2,700 and 2 × 1,350) = 5,400 hp(m))
Auxiliary motor: 1—103 kW (140 hp(m))
Shafts: 3

FURTHER INFORMATION

PROGRAMME

The first of these boats for Cuba arrived in Havana from the (then) USSR on 7 February 1979 and was the first submarine to be operated by a Caribbean navy, other than the US Navy. It was followed by the second in January 1980 and the third in February 1984. As far as is known these are absolutely identical to those supplied to the Soviet Navy.

OPERATIONAL

725 started a five year refit in Havana in March 1986 which was completed in 1992. 727 started a similar refit in July 1989. These submarines have not been seen at sea since 1992 and all are reported to be non-operational.

FOXTROT, INDIA

GENERAL SPECIFICATIONS

Country: India

Class: FOXTROT
Type: 641

Bought: 8
In service: 6

Displacement:
surfaced: 1,952 t
submerged: 2,475 t

Dimensions
Length: 91.3 m (299.5 ft)
Beam: 7.5 m (24.6 ft)
Draught: 6 m (19.7 ft)

Speed:
surfaced: 16 kts
submerged: 15 kts
Range:
surfaced: 20,000 n miles at 8 kts
submerged: 380 n miles at 2 kts
Diving depth: 250 m (820 ft) (reducing with age)

Complement: 75 (8 officers)

SUBMARINES

KURSURA (S 20)
Builder Sudomekh Yard, St Petersburg, Russia
Delivered Dec 1970

KARANJ (S 21)
Builder Sudomekh Yard, St Petersburg, Russia
Delivered Oct 1970

VELA (S 40)
Builder Sudomekh Yard, St Petersburg, Russia
Delivered Nov 1973

VAGIR (S 41)
Builder Sudomekh Yard, St Petersburg, Russia
Delivered Dec 1973

VAGLI (S 42)
Builder Sudomekh Yard, St Petersburg, Russia
Delivered Sep 1974

VAGSHEER (S 43)
Builder Sudomekh Yard, St Petersburg, Russia
Delivered Dec 1975

WEAPONS SYSTEMS

TUBES

10–533 mm (21 in); six bow, four stern.
Total weapon load, 22.

TORPEDOES

SET-65E and SAET-60 torpedoes have been supplied to the Indian Navy.

MINES

44 mines can be carried in lieu of torpedoes.

Specifications

Type/Designator	SET-65E	SAET-60
Role	ASW	ASV
Diameter	533 mm (21 in)	533 mm (21 in)
Length	7.8 m (25.6 ft)	7.8 m (25.6 ft)
Propulsion	electric	electric
Performance	8.1 n miles (15 km) at 40 kts	8.1 n miles (15 km) at 40 kts
Guidance	active/passive	passive
Warhead	205 kg (452 lb)	400 kg (882 lb)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Stop Light
Stop Light is an ESM system for surveillance and threat warning.

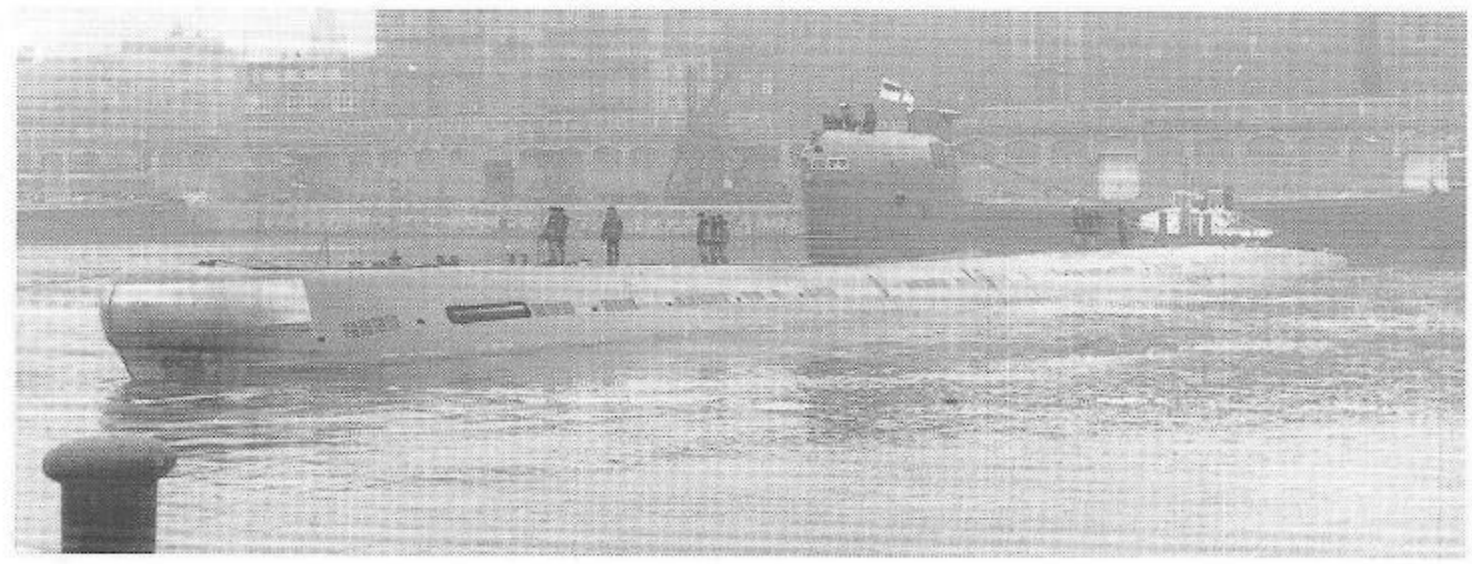
COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Tray
Snoop Tray is an I-band surface search radar of Soviet (Russian) origin. It has a rectangular and only slightly curved antenna.

SONARS

Herkules/Feniks
Herkules was the standard Soviet active/passive search sonar for many years. Hull-mounted, it operates at medium frequencies and is usually mounted in combination with a Feniks attack sonar.



Kanhero *(S 22) is now reported to be used as a source of spares* (H & L van Ginderen Collection)

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 3 Type 37-D diesels; 4.4 MW (6,000 hp(m))
Electric motors: 3 motors; total 3.97 MW 1 × 2,700 and 2 × 1,350 = 5,400 hp(m))
Auxiliary motor: 1 auxiliary motor; 103 kW (140 hp(m))
Shafts: 3

FURTHER INFORMATION

PROGRAMME

On Independence in 1947 the Indian Navy inherited a great deal of ex-British warships from the former Royal Indian Navy, and the service continued for some years to purchase British naval equipment. There was, therefore, considerable surprise in the early 1970s when the service decided not only to operate submarines for the first time, but also to buy them from the (then) Soviet Union.

Eight new construction boats have been purchased in total, all of which were built at the Sudomekh Yard, Leningrad (now St Petersburg, Russia), arriving in India between 1970 and 1975.

MODERNISATION

At least two have been refitted in the USSR: *Kursura* (1985 to 1994) and *Karanj*. Four more may be upgraded pending a firm decision on which class to build next.

OPERATIONAL

Two of the class have already been paid off: *Kandhera* (S 22) in 1990 and *Kalvari* (S 23) in 1992. *Kandhera* has been cannibalised for spares.

There are conflicting reports about the state of operational readiness of the remaining boats, but Indian Navy maintenance is usually to a high standard and there is no reason why these hulls should not survive for another 5 to 10 years, if it is considered cost-effective to keep them going.

There were reports that one might be either sold or lent to Singapore, or to conduct a training and familiarisation course under contract. It would appear, however, that this proposal has been overtaken by Singapore's decision to buy a surplus Swedish submarine (see 'Sjöormen' class).

Vella *(S 40) is one of six 'Foxtrot' class submarines remaining in service with the Indian Navy* (H & L van Ginderen Collection)

FOXTROT, LIBYA

GENERAL SPECIFICATIONS

Country: Libya

Class: FOXTROT
Type: 641

Bought: 6
In service: 4

Displacement:
surfaced: 1,950 t
submerged: 2,475 t

Dimensions
Length: 91.3 (299.5 ft)
Beam: 7.5 m (24.6 ft)
Draught: 6 m (19.7 ft)

Speed:
surfaced: 16 kts
submerged: 15 kts
Range:
surfaced: 20,000 n miles at 8 kts
submerged: 380 n miles at 2 kts
Diving depth: 250 m (820 ft) reducing with age

Complement: 75 (8 officers)

SUBMARINES

AL BADR (311)
Builder Sudomekh Yard, St Petersburg, Russia
Delivered Dec 1976

AL AHAD (313)
Builder Sudomekh Yard, St Petersburg, Russia
Delivered Feb 1978

AL MITRAQA (314)
Builder Sudomekh Yard, St Petersburg, Russia
Delivered Feb 1981

AL HUNAIN (316)
Builder Sudomekh Yard, St Petersburg, Russia
Delivered Feb 1983

WEAPONS SYSTEMS

TUBES

10–533 mm (21 in); six bow, four stern.
Total weapon load, 22.

TORPEDOES

SET-65E and SAET-60 torpedoes have been supplied to the Libyan Navy.

MINES

44 mines may be carried in place of torpedoes.

Specifications

Type/Designator	SET-65E	SAET-60
Role	ASW	ASV
Diameter	533 mm (21 in)	533 mm (21 in)
Length	7.8 m (25.6 ft)	7.8 m (25.6 ft)
Propulsion	electric	electric
Performance	8.1 n miles (15 km) at 40 kts	8.1 n miles (15 km) at 40 kts
Guidance	active/passive	passive
Warhead	205 kg (452 lb)	400 kg (882 lb)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Stop Light
Stop Light is an ESM system for surveillance and threat warning.

COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Tray
Snoop Tray is an I-band surface search radar of Soviet (Russian) origin. It has a rectangular and only slightly curved antenna.

SONARS

Herkules/Feniks
Herkules was the standard Soviet active/passive search sonar for many years. Hull-mounted, it operates at medium frequencies and is usually mounted in combination with a Feniks attack sonar.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 3 Type 37-D diesels; 4.4 MW (6,000 hp(m))

Electric motors: 3 motors; total 3.97 MW (1 × 2,700 and 2 × 1,350 = 5,400 hp(m))
Auxiliary motor: 1 auxiliary motor; 103 kW (140 hp(m))
Shafts: 3

FURTHER INFORMATION

PROGRAMME

These were constructed on the reactivated building line at the Sudomekh Yard in Leningrad and delivered to Libya between 1976 and 1983.

DESIGN

These are of the standard Soviet design, although it appears that the usual HF masts are not fitted.

OPERATIONAL

The Libyan crews were trained in the USSR and much of the maintenance in Libya was done by Russian personnel until 1992. *Al Fateh* (312) was in refit in Riga, Lithuania in 1992 when United Nations sanctions were applied to Libya and all work stopped. The boat was moved to the Russian base at Kronstadt but has now been abandoned and deleted. *Al Khyber* (315) sank alongside in 1993 and none of the others has dived since 1991.

None of these submarines has carried out a routine patrol since 1984 and their value, even as a nuisance, is minimal.

FOXTROT, POLAND

GENERAL SPECIFICATIONS

Country: Poland

Class: FOXTROT
Type: 641

Bought: 2
In service: 2

Displacement:
surfaced: 1,953 t
submerged: 2,475 t

Dimensions
Length: 91.3 m (299.54 ft)
Beam: 8.00 m (26.25 ft)
Draught: 7.35 m (24.11 ft)

Speed:
surfaced: 16.5 kts
snorting: 9.0 kts
submerged: 15.5 kts

Diving depth:
operational: 240 m (820 ft)
max: 300 m (984 ft)
Range:
surfaced: 20,000 n miles at 8 kts
submerged: 380 n miles at 2 kts

Complement: 75 (12 officers)

SUBMARINES

WILK (292)	
Builder	Sudomekh Yard, St Petersburg, Russia
Launched	1964
Recommissioned	3 Nov 1987

DZIK (293)	
Builder	Sudomekh Yard, St Petersburg, Russia
Laid down	25 Mar 1966
Launched	20 May 1966
Recommissioned	7 Dec 1988

WEAPONS SYSTEMS

TUBES

10–533 mm (21 in); six bow, four stern.
Total weapon load, 22.

MINES

44 mines can be carried in lieu of torpedoes.

TORPEDOES

Type/Designator	Type 53-56	SET-65E	SAET-60
Role	ASV	ASW	ASV
Diameter	533 mm (21 in)	533 mm (21 in)	533 mm (21 in)
Length	7.8 m (25.6 ft)	7.8 m (25.6 ft)	7.8 m (25.6 ft)
Propulsion	turbine	electric	electric
Performance	13.4 n miles (25 km) at 50 kts	8.1 n miles (15 km) at 40 kts	8.1 n miles (15 km) at 40 kts
Guidance	passive/wake	active/passive	passive
Warhead	300 kg (661 lb)	205 kg (452 lb)	400 kg (882 lb)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Ankier (NATO = Stop Light)

Ankier is an ESM system for surveillance and threat warning.

COMMAND AND CONTROL SYSTEMS

RADAR

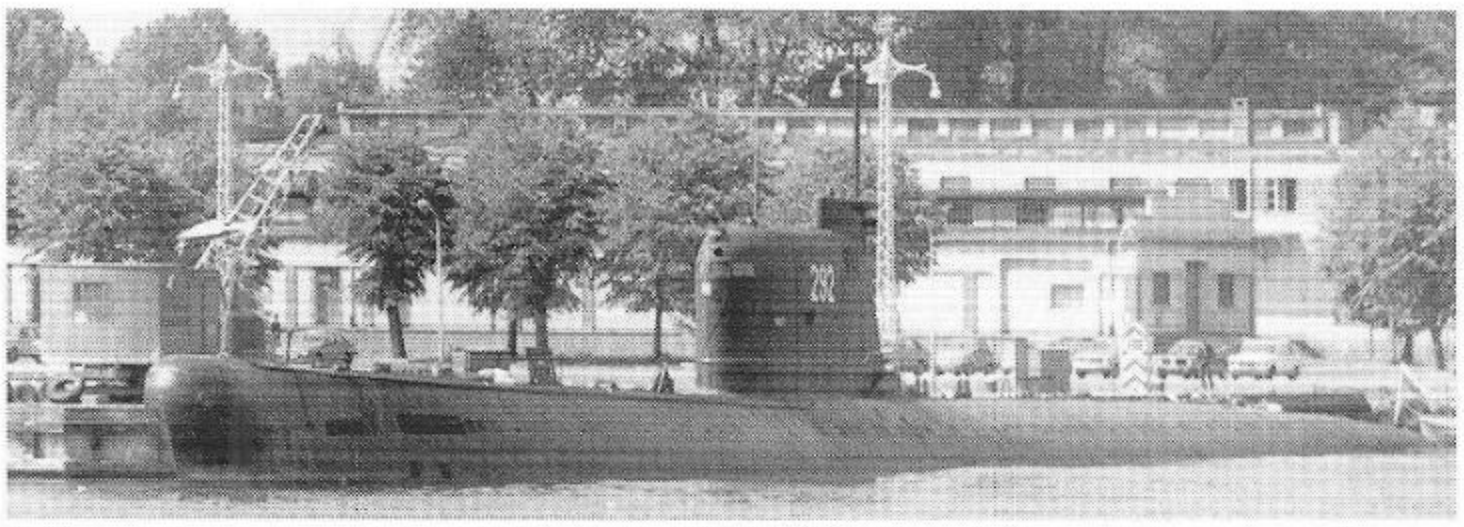
Snoop Tray

Snoop Tray is an I-band surface search radar of Soviet (Russian) origin. It has a rectangular and only slightly curved antenna. It is designated RLK-101 'Flag' in Polish service.

SONARS

Herkules/Feniks

Herkules was the standard Soviet active/passive search sonar for many years. Hull-mounted, it operates at medium frequencies and is usually mounted in combination with a Feniks attack sonar.



Polish submarine Dzik *(293) shows its sonars. The large horizontal sonar inset in the bow is known to NATO as Trout Cheek (Russian = Herkules). It is a passive, low-frequency system. The dome on the upper casing is Feniks attack sonar, while the small cylinder on top of Feniks is Fez, an HF system probably used as an underwater telephone* (H & L van Ginderen Collection)

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 3 Type 37-D diesels; 4.4 MW (6,000 hp(m))
Electric motors: 1 PG-102K; 1,985 kW (2,700 hp); 2 PG-101K; 2 × 992 kW (1,350 hp)
Auxiliary motor: 1 auxiliary motor; 103 kW (140 hp(m))
Shafts: 3

Wilk *(292) one of two 'Foxtrot' class submarines in service with the Polish Navy* (H & L van Ginderen Collection)

FURTHER INFORMATION

PROGRAMME

The Polish Navy has operated Soviet/Russian-supplied submarines since 1954 and originally intended to replace its four Whiskey V boats with two 'Kilo' class. After taking delivery of the first Kilo, however, the Polish Navy decided that it was unsuitable for operation in the restricted waters of the Baltic and, instead of a second Kilo, two Foxtrots were supplied on loan from Russian Navy stocks in 1987/88. These were subsequently purchased outright in 1993.

MODERNISATION

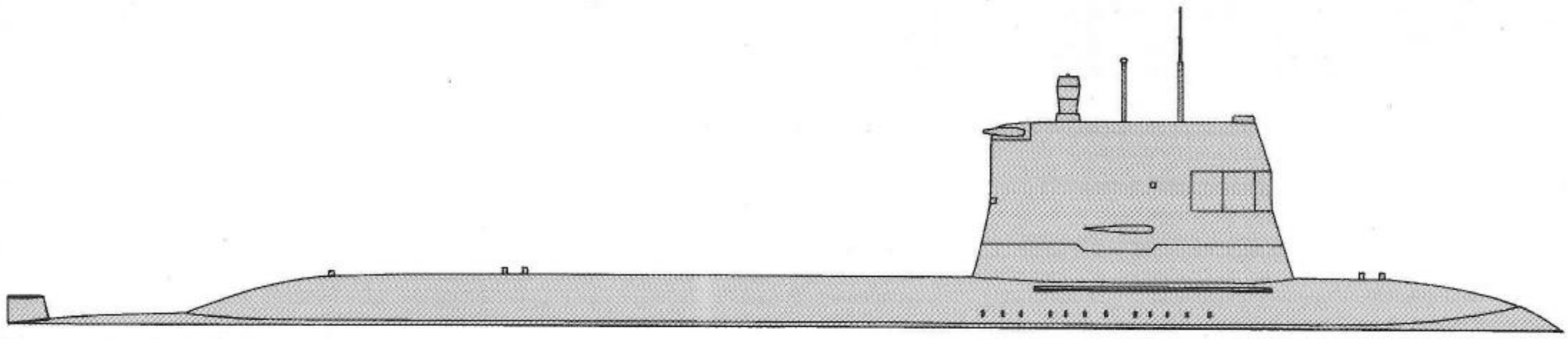
Wilk was given a six-month refit in 1993.

OPERATIONAL

The Polish Navy considers that the Foxtrot is the largest practical size of submarine for Baltic operations. Both are based with the 3rd Submarine Division at Gdynia.

This stern view of Wilk *(292) shows the very tall HF mast (and deck cradle for the mast when lowered) and the snort tube inset in the after end of the sail*
(H & L van Ginderen Collection)

SJÖORMEN



Sjöormen (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Sweden

Class: SJÖORMEN
Type: A 12

Built: 5
In service: 3

Displacement:
surfaced: 1,130 t
submerged: 1,210 t

Dimensions
Length: 51 m (167.3 ft)
Beam: 6.1 m (20 ft)
Draught: 5.8 m (19 ft)

Speed:
surfaced: 12 kts
submerged: 20 kts
Endurance: 21 days
Diving depth: 150 m (492 ft)

Complement: 23 (7 officers)

SUBMARINES

Sjölejonet (Sle)

Builder	Kockums, Malmö, Sweden
Laid down	1966
Launched	29 Jun 1967
Commissioned	16 Dec 1968

Sjöhunden (Shu)

Builder	Kockums, Malmö, Sweden
Laid down	1966
Launched	21 Mar 1968
Commissioned	25 Jun 1969

Sjöhästen (Shä)

Builder	Karlskronavarvet, Karlskrona, Sweden
Laid down	1966
Launched	9 Jan 1968
Commissioned	15 Sep 1969

WEAPONS SYSTEMS

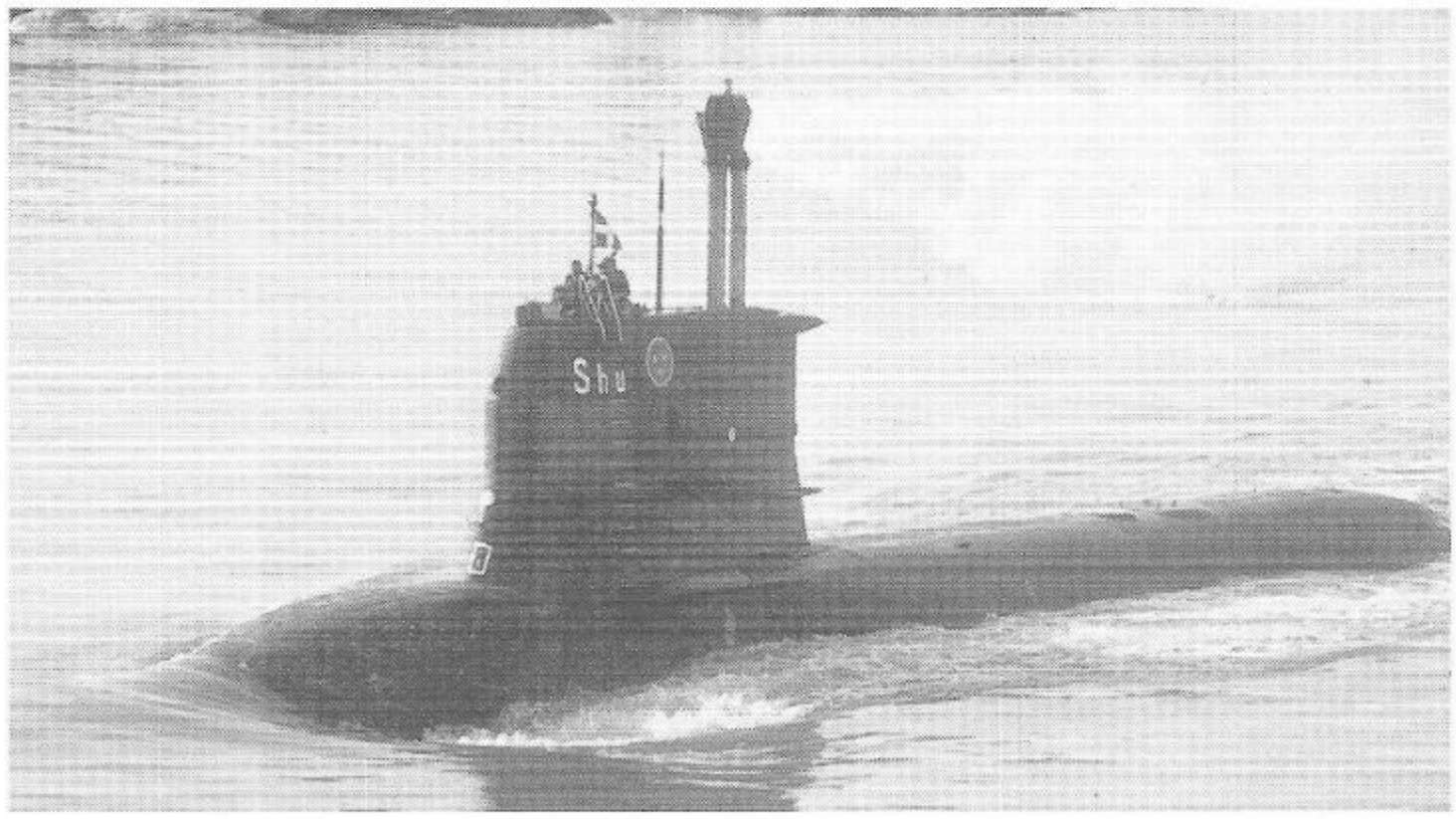
TUBES

Four 533 mm (21 in) and two 400 mm (15.75 in) tubes; bow.
Total weapon load, 8 × 533 mm; 4 × 400 mm.

TORPEDOES

Bofors Type 613 torpedo

The Type 613 is a homing, wire-guided, long-range torpedo for use against surface targets. It uses a thermal propulsion system with hydrogen peroxide/alcohol/water as propellants and is designed around a programmable digital computer which controls the homing system, communication with the launching fire-control system and the torpedo navigation system. The combination of homing and wire guidance is claimed to result in very high hit probability, even at long firing ranges. The torpedo is equipped with both impact and computerised proximity fuzes, both of which can be controlled from the launching fire-control system.



Sjöhunden *(Shu) is one of the three 1960s-vintage 'Sjöormen' class submarines remaining in service with the Swedish Navy* (H & L van Ginderen Collection)

Specifications
Length: 7.03 m (23.05 ft)
Diameter: 533 mm (21 in)
Weight: 1,765 kg (3,891 lb)
Warhead: 250 kg (551 lb)
Speed: 25 kts
Range: 16.2 n miles (30 km)
Propulsion: Energy produced by combusting alcohol with hydrogen peroxide as an oxidiser. Two-speed valve steam engine with gearbox

Manufacturer/Contractor
Bofors Underwater Systems, Motala, Sweden.

Bofors Type 431

The Type 431 is a 400 mm diameter, wire-guided torpedo with a homing system optimised for use against very silent submarines in shallow water, using an acoustic detector which distinguishes between target and disruptive noise. The combination of homing and wire guidance is claimed to result in a very high hit probability even at long firing ranges. The torpedo has three speeds selectable during its run to the target and is equipped with impact and computerised proximity fuzes, both of which can be controlled from the launcher fire-control system. The guidance wire communication link permits the launching craft to transmit orders to the torpedo, controlling speed, depth, course and target data, while the torpedo reports its position, speed, course and depth, homing systems parameters and target noise. If communications are lost, the torpedo's onboard computer calculates the expected target position, guides the torpedo to the predicted point of impact and initiates one of the several possible search patterns.

Specifications
Length: 2.65 m (8.68 ft)
Diameter: 400 mm (15.75 in)
Guidance: Wire-guided
Homing: Active/passive
Weight: 350 kg (including battery and guidance wire)
Warhead: 45 kg (99.2 lb) shaped charge HE
Propulsion: Secondary silver/zinc (Ag/ZnO) battery 4.2/5.6 kW h
Speed: 15, 25, 35 kts
Range: 10.8 n miles (20 km) at 25 kts

Manufacturer/Contractor
Bofors Underwater Systems, Motala, Sweden.

MINES

Mines can be carried internally in lieu of torpedoes.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

CelsiusTech NEDPS
The 'Sjöormen' class was retrofitted with the Celsius-Tech NEDPS action information and fire-control system during the mid-life upgrade.

RADAR

Navigation: Terma; I band.

SONARS

Plessey Hydra; hull-mounted; passive search and attack; medium frequency.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 Hedemora-Pielstick V12A/A2/15 diesels; 1.62 MW (2,200 hp(m))

Electric motor: 1 ASEA motor; 1.1 MW (1,500 hp(m))
Shaft: 1

FURTHER INFORMATION

PROGRAMME

Sweden has maintained a submarine construction and design capability for many years, producing successive types in just sufficient numbers to keep the shipyards busy. The 'Sjöormen' class was designed in the early 1960s and five were built, entering service with the RSwedN between 1967 and 1969, where they replaced the 'U1' class.

Two boats were deleted in 1996, with *Sjöbjörnen* being sold to Singapore (see below), while *Sjöormen* remains in Swedish hands, at least in the short term. Of the three boats that remain, two have undergone substantial modernisation and will serve on for some years, while the third, unmodified boat, will be either stricken or sold.

DESIGN

The previous class to be built, the 'Draken' class, was a conventional 1950s design, with a long, thin hull, twin propellers, and an armament of four 533 mm torpedo tubes. The Sjöormen design, however, was radically different, its principle novelty being a 'tear-drop' hull, although it would be incorrect to describe it as an 'Albacore-hull', since it is quite different in shape to that revolutionary US submarine. The Sjöormen's control surfaces were also of a totally new layout for Swedish submarines, with X-planes aft and sail-mounted forward hydroplanes. Finally, the design also introduced the unique Swedish torpedo layout, with a row of 533 mm tubes above and a row of 400 mm tubes below, with reloads positioned on an automated loading rack immediately behing the tubes.

MODERNISATION

All five boats were modernised in 1984-85, receiving Ericsson IBS-A17 combat data/fire-control system, and Krupp-Atlas CSU-3-2 sonar suites.

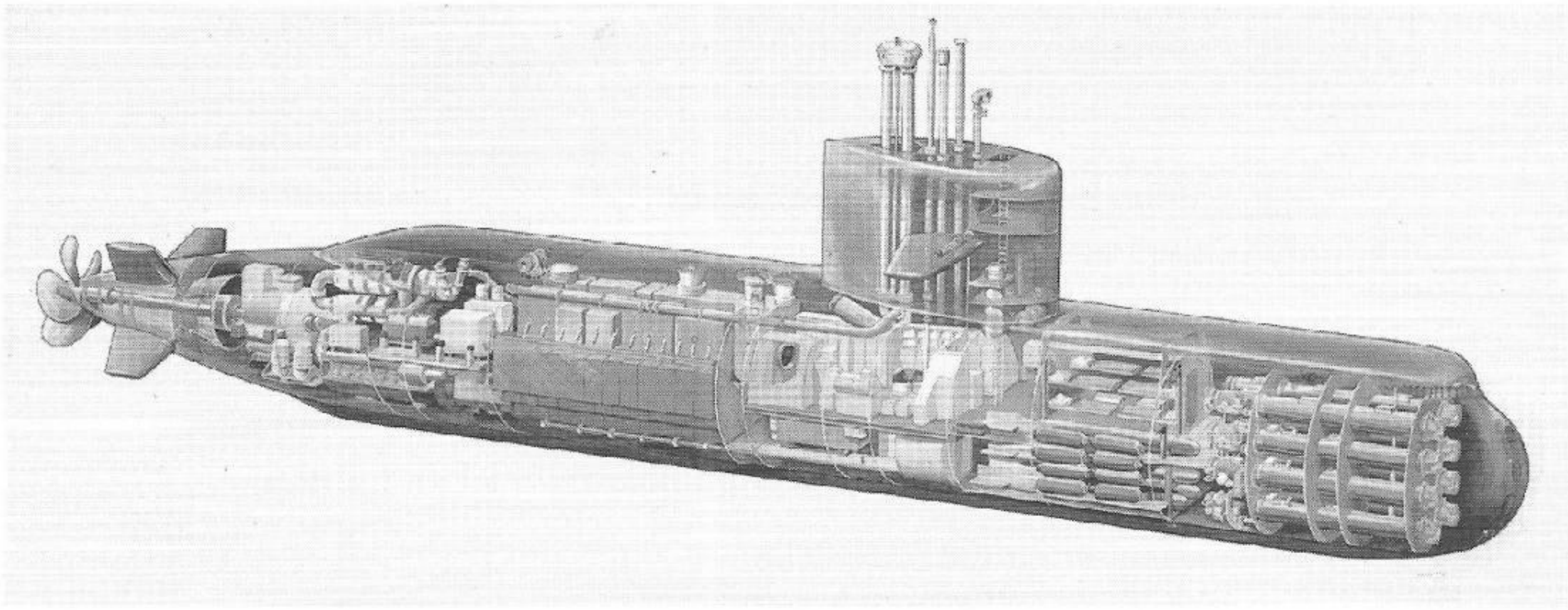
Sjölejonet and *Sjöhunden* then received a 'mid-life' update in 1992-94, which included the Plessey Hydra sonar suite, which is essentially similar to the British Navy's Type 2074. They also received the same electronic systems as those installed in the 'Näcken' class during their latest refits. This will extend the operational lives of these two boats into the late 1990s.

Singapore
Sjöbjörnen was sold to the Singapore Navy in 1996 to meet that service's requirements for a boat to enable them to assess their requirements for a submarine squadron. Some 40 Singaporeans are in Sweden undergoing training and the boat will operate under Swedish operational command until early 1997, when it will sail for Singapore for further trials in local waters.

Sjolejonet *(Sle) with figures on deck to give a scale to these relatively small submarines* (H & L van Ginderen Collection)

Sjöhästen *(Shä)* (H & L van Ginderen Collection)

NÄCKEN



Cutaway of Näcken, showing the heavy torpedo battery of six 533 mm tubes and (at the bottom) two 400 mm tubes (Kockums)

GENERAL SPECIFICATIONS

Country: Sweden

Class: NÄCKEN
Type: A 14

Built: 3
In service: 2

Displacement:
surfaced: 1,015 t
submerged: 1,085 t

Dimensions
Length: 49.5 m (162.4 ft)
Beam: 5.7 m (18.7 ft)
Draught: 5.5 m (18 ft)

Speed:
surfaced: 12 kts
submerged: 20 kts
Diving depth: 300 m (984 ft)

Complement: 27 (5 officers)

SUBMARINES

NAJAD (Naj)

Builder	Kockums, Malmö, Sweden/ Karlskronavarvet, Karlskrona
Laid down	Sep 1973
Launched	6 Dec 1978
Commissioned	26 Jun 1981

NEPTUN (Nep)

Builder	Kockums, Malmö, Sweden
Laid down	Mar 1974
Launched	13 Aug 1979
Commissioned	5 Dec 1980

WEAPONS SYSTEMS

TUBES

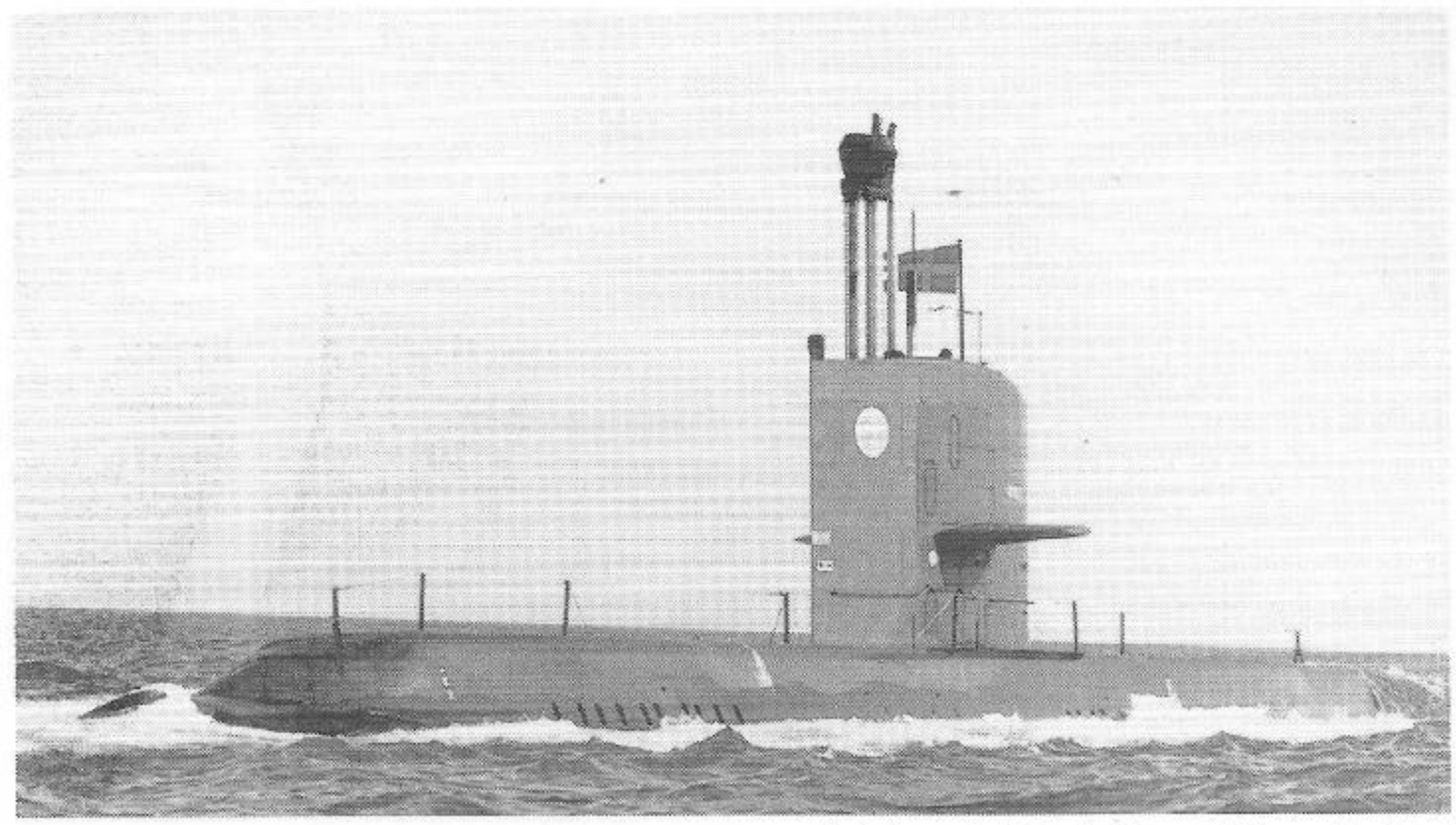
Six 533 mm (21 in); two 400 mm (15.75 in); bow.
Total weapon load, 4 × 400 mm; 8 × 533 mm torpedoes.

TORPEDOES

Bofors Type 613 torpedo

The Type 613 is a homing, wire-guided, long-range torpedo for use against surface targets. It uses a thermal propulsion system with hydrogen peroxide/alcohol/water as propellants and is designed around a programmable digital computer which controls the homing system, communication with the launching fire-control system and the torpedo navigation system. The combination of homing and wire guidance is claimed to result in very high hit probability, even at long firing ranges. The torpedo is equipped with both impact and computerised proximity fuzes, both of which can be controlled from the launching fire-control system.

Specifications
Length: 7.03 m (23.0 ft)
Diameter: 533 mm (21 in)
Weight: 1,765 kg (3,891 lb)
Warhead: 250 kg (551 lb)
Speed: 25 kts
Range: 16.20 n miles (30 km)
Propulsion: Energy produced by combusting alcohol with hydrogen peroxide as an oxidiser. Two-speed valve steam engine with gearbox



Najad *(Naj). Both original members of this class are currently being rebuilt and will remain in service for at least another 10 years* (H & L van Ginderen Collection)

Manufacturer/Contractor
Bofors AB, Motala, Sweden.

Bofors Type 431

The Type 431 is a 400 mm diameter, wire-guided torpedo with a homing system optimised for use against very silent submarines in shallow water, using an acoustic detector which distinguishes between target and disruptive noise. The combination of homing and wire guidance is claimed to result in a very high hit probability even at long firing ranges. The torpedo has three speeds selectable during its run to the target and is equipped with impact and computerised proximity fuzes, both of which can be controlled from the launcher fire-control system. The guidance wire communication link permits the launching craft to transmit

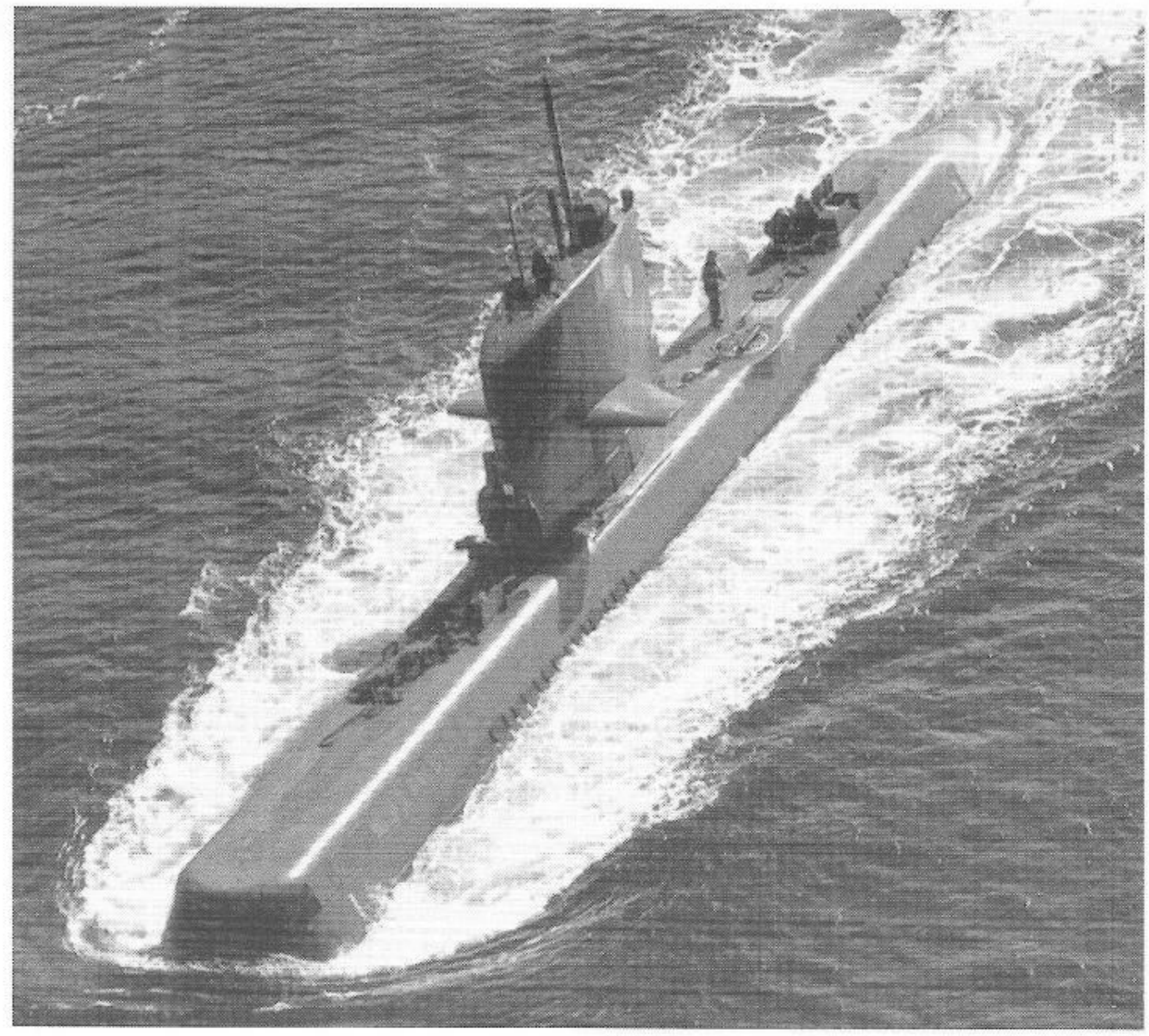
orders to the torpedo, controlling speed, depth, course and target data, while the torpedo reports its position, speed, course and depth, homing systems parameters and target noise. If communications are lost, the torpedo's onboard computer calculates the expected target position, guides the torpedo to the predicted point of impact and initiates one of the several possible search patterns.

Specifications
Length: 2.65 m (8.68 ft)
Diameter: 400 mm (15.7 in)
Guidance: Wire-guided
Homing: Active/passive
Weight: 350 kg (771.6 lb) (including battery and guidance wire)
Warhead: 45 kg (99.2 lb) shaped charge HE
Propulsion: Secondary silver-zinc (Ag/ZnO) battery 4.2/5.6 kW h
Speed: 15, 25, 35 kts
Range: 10.8 n miles (20 km) at 25 kts

Manufacturer/Contractor
Bofors AB, Motala, Sweden.

MINES

These submarines can carry up to 18 mines internally, in lieu of torpedoes.



Neptun *(Nep)* (H & L van Ginderen Collection)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT SYSTEMS (ESM)

ARGOSystems
There is an ARGOSystems radar warning set.

COMMAND AND CONTROL SYSTEMS

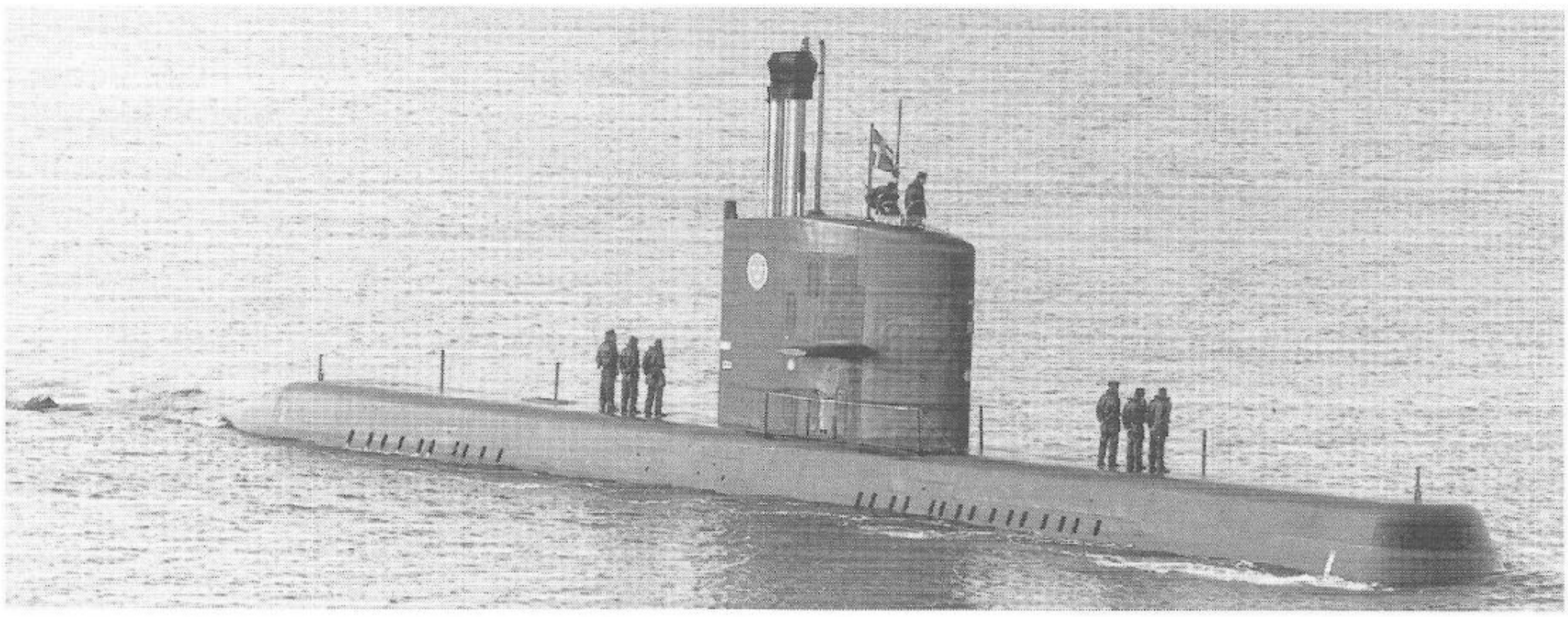
COMBAT DATA AND WEAPONS CONTROL

CelsiusTech NEDPS action information and fire-control system
NEDPS (Näcken Electronic Data Processing System) was developed specifically for use in the 'Näcken' class submarines. A fully integrated system, it is designed to acquire, process and display information for tactical evaluation and thus form the basis for decisions regarding selected targets and torpedo guidance. The system includes complete hardware and software for controlling wire-guided homing torpedoes.

There are two computers which are fed information from an extensive data-collecting system from the different surveillance, weapon and navigation systems. The data are then processed and presented to the operators. After target acquisition the tracking is carried out automatically with relevant fire-control data being calculated continuously. Torpedoes are normally controlled fully automatically after firing with graphic and alphanumeric presentation of all relevant information, but manual override of the tactical and fire-control displays is available at all times.

The operational plot provides an extensive range of supplementary information, including: own submarine operational area; own submarine movements together with navigation reference points and times; operational areas for other submarines; minefields; coastal radar stations with radar parameters. The plot also displays up to 50 internal labelled targets, 10 target channels for target motion-calculated targets; 240 external (via datalink) targets with target numbers and identities; and 32 ESM lines. The tactical plot is used for the passive sonar TMA calculations on up to 10 targets simultaneously. On the 'Näcken' class this plot is manned by the executive officer who supervises the fire-control operator as well as the sonar, radar and ESM operators. He also handles the periscope observations made by the commander.

NEDPS also provides the Ship's Monitoring System (SMS) which monitors functions, such as propulsion,



Najad *(Naj)* (H & L van Ginderen Collection)

steering, depth keeping, trim, and storage battery condition.

Manufacturer/Contractor
CelsiusTech Systems AB, Jarfalla, Sweden.

RADAR

Navigation: Terma; I band.

SONAR

STN Atlas CSU-83 sonar suite
The CSU-83 (DBQS-21) sonar suite is designed for submarines of 400 tonnes displacement and upwards, and is the primary sensor of the submarine fire-control and command system of the German Navy. It comprises a passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array covering the frequencies 10 Hz to 2 kHz, a towed array, and two self-noise detectors. The system is claimed to provide high probability of detection over 360°.

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 1 MTU 16 V 652 MB80 diesel; 1.27 MW (1,730 hp(m))
Electric motor: 1 Jeumont Schneider motor; 1.32 MW (1,800 hp(m))
Shaft: 1

FURTHER INFORMATION

PROGRAMME

As usual in Sweden, laying down the first of the next class of submarine followed closely on completion of the last of the previous class. Thus, the Näcken design followed on from the Sjöormen as a replacement for three of the six-strong 'Draken' class, with the first of class, *Näcken,* being laid down in November 1972. The three 'Näcken' class boats entered service in 1980/81.

DESIGN

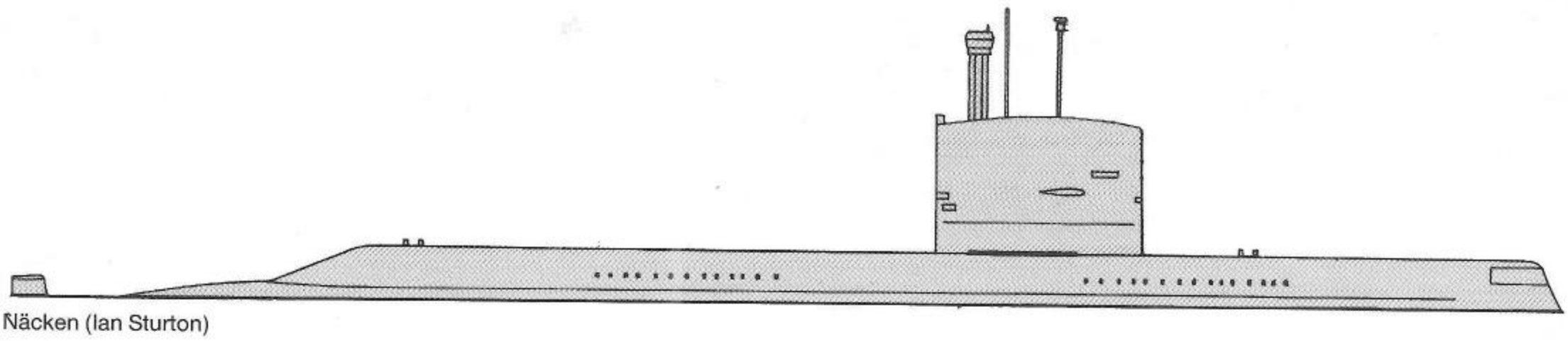
Following construction of the 'Sjöormen' class the Royal Swedish Navy re-examined the design using computer analysis and arrived at a rather different result with a longer, parallel-sided hull with a high beam to length ratio, and a very angular sail located further aft.

There is a large bow-mounted sonar and the main accommodation space is abaft the control room with machinery spaces right aft. Unlike most other submarines, there is just one combined search and attack periscope.

MODERNISATION

Näcken has been converted into a hybrid-powered submarine (see Näcken Modified below). Work started in 1993 to update both the two remaining non-AIP boats and the modified Näcken. All three are being fitted with new weapon control systems, automated torpedo tubes and new sonars, which will extend their service lives well into the next century. This update is scheduled to complete in 1998.

NÄCKEN MODIFIED (A 14 MOD)



Näcken (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Sweden

Class: NÄCKEN (MODIFIED)
Type: A 14 (Modified)

Modified: 1
In service: 1

Displacement:
submerged: 1,300 t

Dimensions
Length: 57.5 m (182.1 ft)
Beam: 5.7 m (18.7 ft)
Draught: 5.5 m (18 ft)

Speed:
surfaced: 12 kts
submerged: batteries 20 kts; AIP 5 kts
Diving depth: 300 m (984 ft)

Complement: 27 (5 officers)

SUBMARINES

NÄCKEN (Näk)			
Builder	Kockums, Malmö, Sweden	**Commissioned**	25 Apr 1980
Laid down	Nov 1972	**Conversion**	Nov 1987-Nov 1988
Launched	17 Apr 1978	**Relaunched**	6 Sep 1988
		Recommissioned	11 May 1989

WEAPONS SYSTEMS

TUBES

Six 533 mm (21 in); two 400 mm (15.75 in); bow.
Total weapon load, 4 × 400 mm; 8 × 533 mm.

TORPEDOES

Bofors Type 613 torpedo

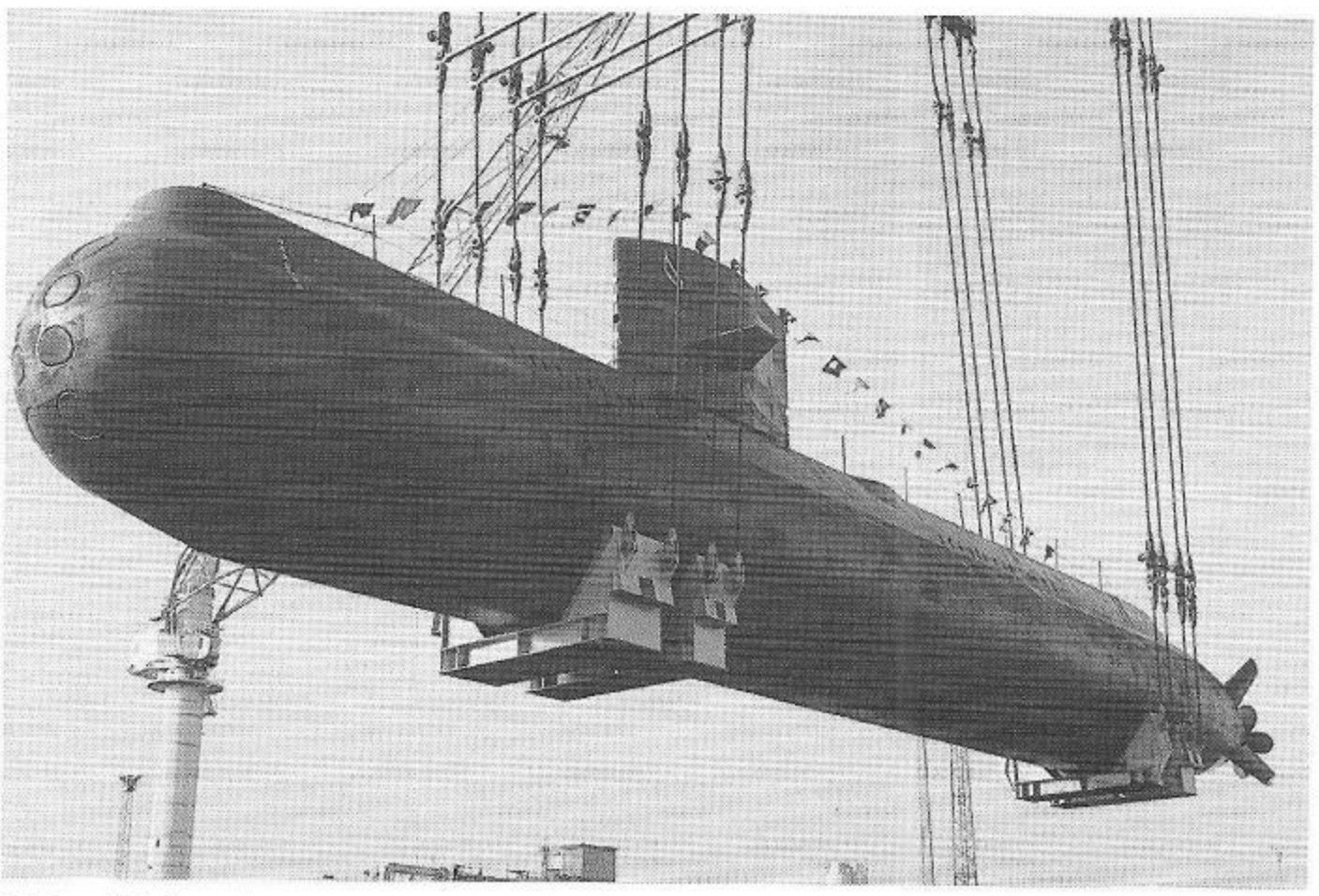
The Type 613 is a homing, wire-guided, long-range torpedo for use against surface targets. It uses a thermal propulsion system with hydrogen peroxide/alcohol/water as propellants and is designed around a programmable digital computer which controls the homing system, communication with the launching fire-control system and the torpedo navigation system. The combination of homing and wire guidance is claimed to result in very high hit probability, even at long firing ranges. The torpedo is equipped with both impact and computerised proximity fuzes, both of which can be controlled from the launching fire-control system.

Specifications
Length: 7.03 m (23.0 ft)
Diameter: 533 mm (21 in)
Weight: 1,765 kg (3,891 lb)
Warhead: 250 kg (551 lb)
Speed: 25 kts
Range: 16.20 n miles (30 km)
Propulsion: Energy produced by combusting alcohol with hydrogen peroxide as an oxidiser. Two-speed valve steam engine with gearbox

Manufacturer/Contractor
Bofors AB, Motala, Sweden.

Bofors Type 431

The Type 431 is a 400 mm diameter, wire-guided torpedo with a homing system optimised for use against very silent submarines in shallow water, using an acoustic detector which distinguishes between target and disruptive noise. The combination of homing and wire guidance is claimed to result in a very high hit probability even at long firing ranges. The torpedo has three speeds selectable during its run to the target and is equipped with impact and computerised proximity fuzes, both of which can be controlled from the launcher fire-control system. The guidance wire communication link permits the launching craft to transmit orders to the torpedo, controlling speed, depth, course and target data, while the torpedo reports its position, speed, course and depth, homing systems parameters and target noise. If communications are lost, the torpedo's onboard computer calculates the expected target position, guides the torpedo to the predicted point of impact and initiates one of the several possible search patterns.



Näcken (Kockums)

The Stirling compartment in Näcken (Kockums)

Specifications
Length: 2.65 m (8.68 ft)
Diameter: 400 mm (15.7 in)
Guidance: Wire-guided
Homing: Active/passive
Weight: 350 kg (771.6 lb) (including battery and guidance wire)
Warhead: 45 kg (99.2 lb) shaped charge HE

Propulsion: Secondary silver-zinc (Ag/ZnO) battery 4.2/5.6 kW h
Speed: 15, 25, 35 kts
Range: 10.8 n miles (20 km) at 25 kts

Manufacturer/Contractor
Bofors AB, Motala, Sweden.

MINES

This submarine can be fitted with an OMA (outboard mine attachment) strap-on mine 'girdle' carrying 48 mines, or it can carry up to 18 mines internally, in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT SYSTEMS (ESM)

ARGOSystems
There is an ARGOSystems radar warning set.

COMMAND AND CONTROL SYSTEMS

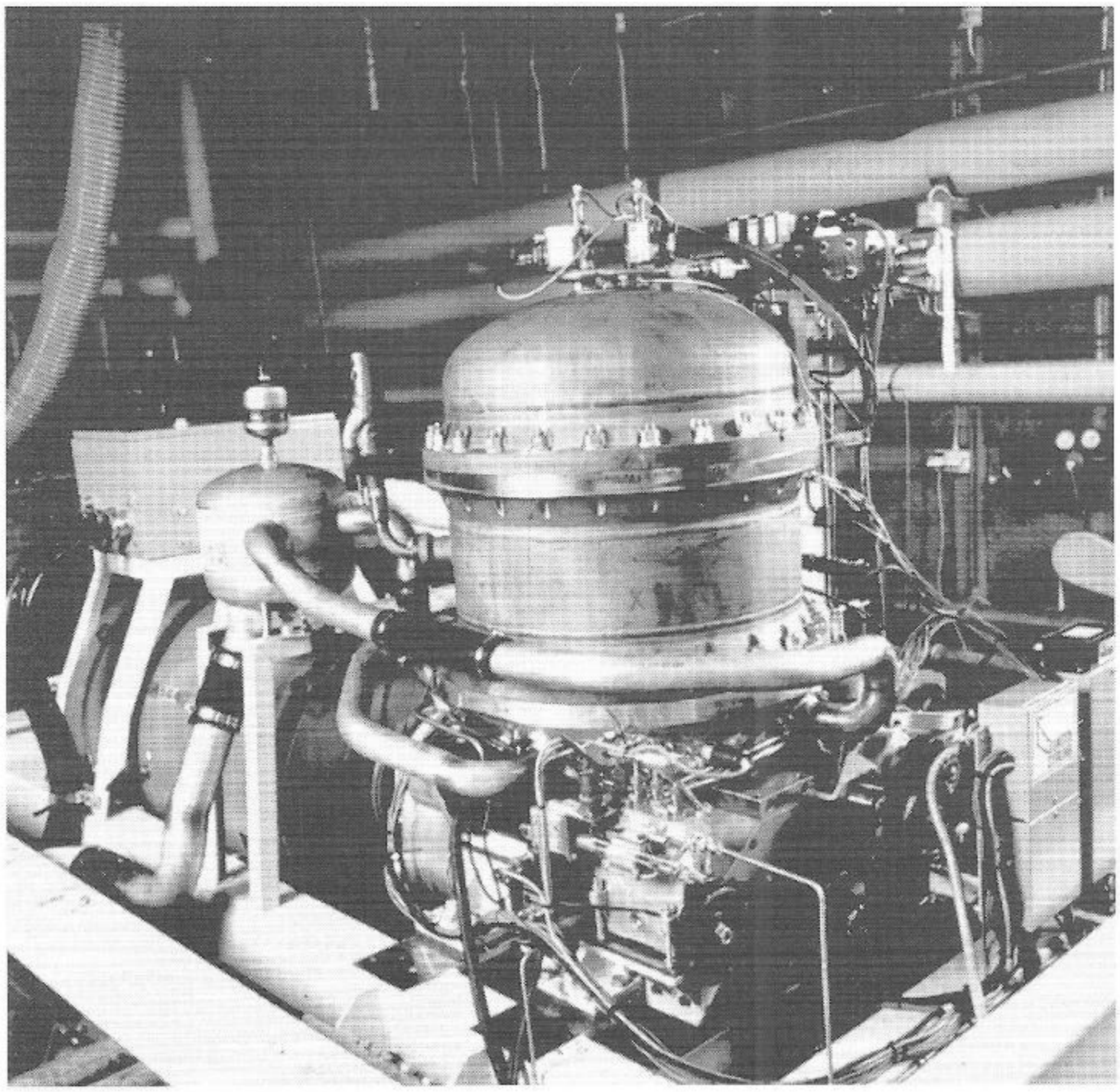
COMMAND DATA AND WEAPONS CONTROL

CelsiusTech NEDPS action information and fire-control system
NEDPS (Näcken Electronic Data Processing System) was developed specifically for use in the 'Näcken' class submarines. A fully integrated system, it is designed to acquire, process and display information for tactical evaluation and thus form the basis for decisions regarding selected targets and torpedo guidance. The system includes complete hardware and software for controlling wire-guided homing torpedoes.

There are two computers which are fed information from an extensive data-collecting system from the different surveillance, weapon and navigation systems. The data are then processed and presented to the operators. After target acquisition the tracking is carried out automatically with relevant fire-control data being calculated continuously. Torpedoes are normally controlled fully automatically after firing with graphic and alphanumeric presentation of all relevant information, but manual override of the tactical and fire-control displays is available at all times.

The operational plot provides an extensive range of supplementary information, including: own submarine operational area; own submarine movements together with navigation reference points and times; operational areas for other submarines; minefields; coastal radar stations with radar parameters. The plot also displays up to 50 internal labelled targets, 10 target channels for target motion-calculated targets; 240 external (via data-link) targets with target numbers and identities; and 32 ESM lines. The tactical plot is used for the passive sonar TMA calculations on up to 10 targets simultaneously. On the 'Näcken' class this plot is manned by the executive officer who supervises the fire-control operator as well as the sonar, radar and ESM operators. He also handles the periscope observations made by the commander.

NEDPS also provides the Ship's Monitoring System (SMS) which monitors functions, such as propulsion, steering, depth keeping, trim, and storage battery condition.



Close-up of the Näcken's *Stirling unit* (Kockums)

Manufacturer/Contractor
CelsiusTech Systems AB, Jarfalla, Sweden.

RADAR

Navigation: Terma; I band.

SONAR

STN Atlas CSU-83 sonar suite
The CSU-83 (DBQS-21) sonar suite is designed for submarines of 400 tonnes displacement and upwards, and is the primary sensor of the submarine fire-control and command system of the German Navy. It comprises a passive bow array operating in the 0.3 to 12 kHz band, a passive ranging array covering the frequencies 10 Hz to 2 kHz, a towed array, and two self-noise detectors. The system is claimed to provide high probability of detection over 360°.

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 1 MTU 16V 652 MB80 diesel; 1.27 MW (1,730 hp(m))
Air-independent propulsion system: 2 Stirling V4-275R Mk 1 engines; 150 kW

Electric motor: 1 Jeumont Schneider motor; 1.32 MW (1,800 hp(m))
Shaft: 1

FURTHER INFORMATION

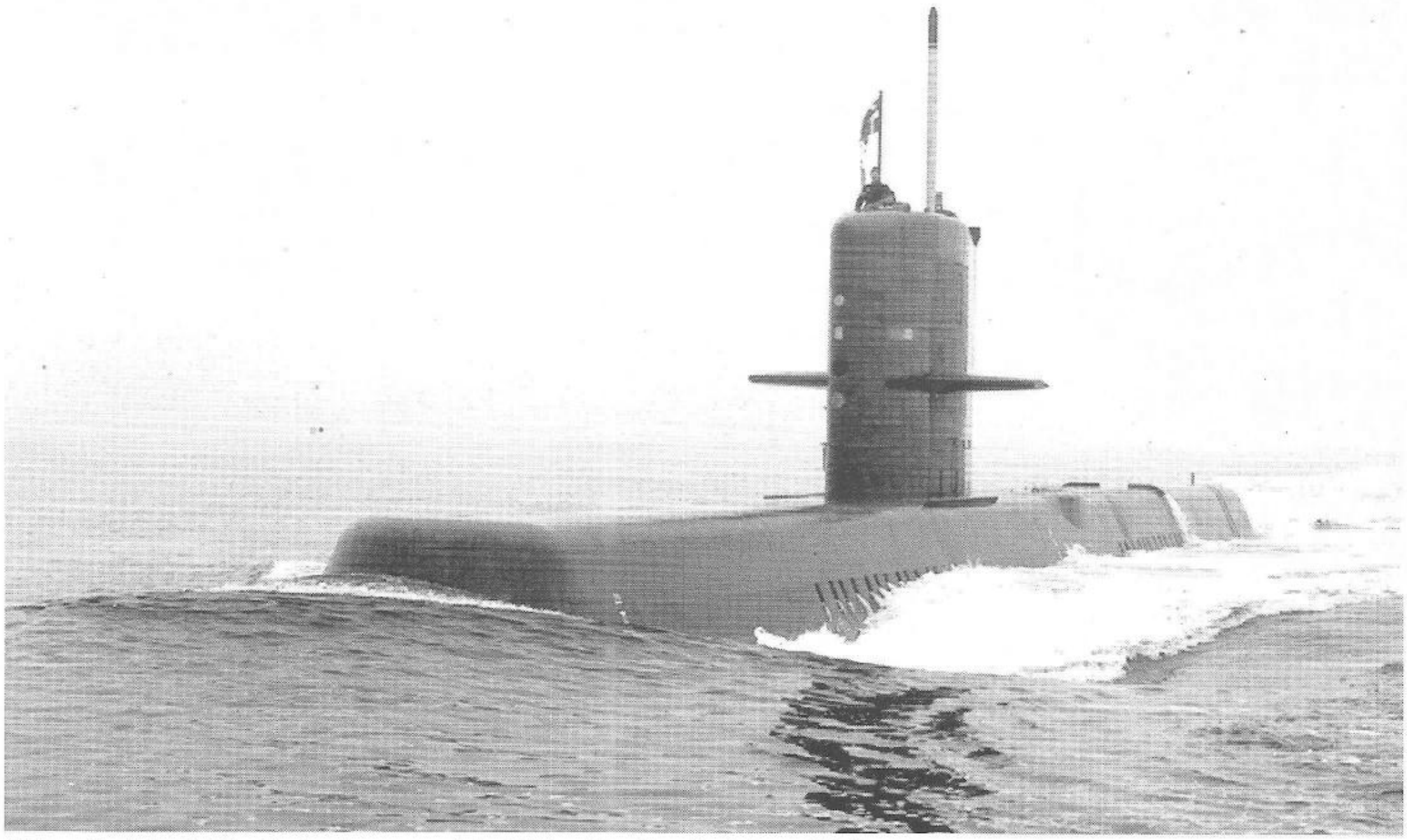
MODERNISATION

The significance of the Näcken conversion is that the submarine remains a fully operational boat and is not a 'one-off' non-operational prototype. *Näcken* was taken in hand by Kockums in November 1987 for the installation of a closed-circuit Stirling diesel, which provides non-nuclear propulsion without requiring access to the atmosphere; that is, air-independent propulsion (AIP). The conversion involved the insertion of a new 6 m (19.68 ft) long section, which was neutrally buoyant and contained the Stirling generators, two LOX (liquid-oxygen) supply tanks, and control systems. The boat was relaunched on 6 September 1988.

As with the other two, *Näcken* will be further updated with new weapon control systems, torpedo tube automation and new sonars, to extend its service life into the next century. This update is scheduled to complete in 1998.

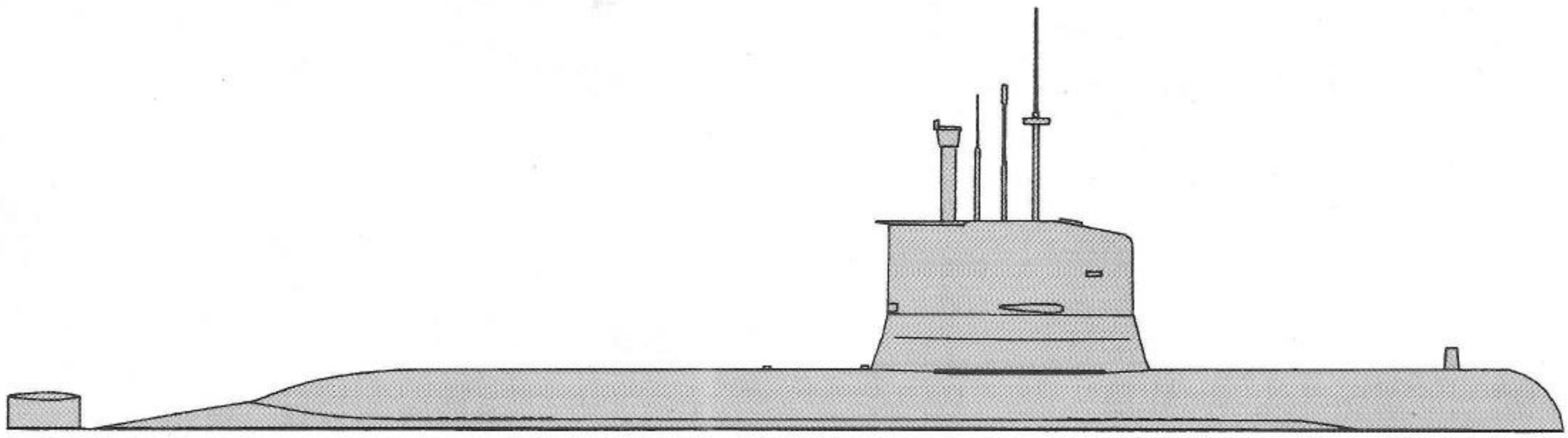
OPERATIONAL

Post-conversion trials started on 23 November 1988 and were so successful that the submarine was able to return to operational service on 11 April 1989. The Stirling engine is used for submerged patrols at low speed, with low use of battery power. Liquid oxygen (LOX) provides the combustible air and the exhaust products dissolve in water. The engine gives a fully submerged endurance of up to 14 days.



Näcken *after being stretched by 6 m to accommodate a Stirling AIP unit, making it the world's first operational AIP submarine* (Kockums)

VÄSTERGÖTLAND



Västergötland (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Sweden

Class: VÄSTERGÖTLAND
Type: A 17

Built: 4
In service: 4

Displacement:
surfaced: 1,070 t
submerged: 1,143 t

Dimensions
Length: 48.5 m (159.1 ft)
Beam: 6.1 m (20 ft)
Draught: 5.6 m (18.4 ft)

Speed:
surfaced: 11 kts
submerged: 20 kts

Complement: 28 (5 officers)

SUBMARINES

VÄSTERGÖTLAND (Vgd)
Builder Kockums, Malmö, Sweden
Laid down 10 Jan 1983
Launched 17 Sep 1986
Commissioned 27 Nov 1987

HÄLSINGLAND (Hgd)
Builder Kockums, Malmö, Sweden
Laid down 1 Jan 1984
Launched 31 Aug 1987
Commissioned 20 Oct 1988

SÖDERMANLAND (Söd)
Builder Kockums, Malmö, Sweden
Laid down 1985
Launched 12 Apr 1988
Commissioned 21 Apr 1989

ÖSTERGÖTLAND (Ögd)
Builder Kockums, Malmö, Sweden
Laid down 1986
Launched 9 Dec 1988
Commissioned 10 Jan 1990

WEAPONS SYSTEMS

TUBES

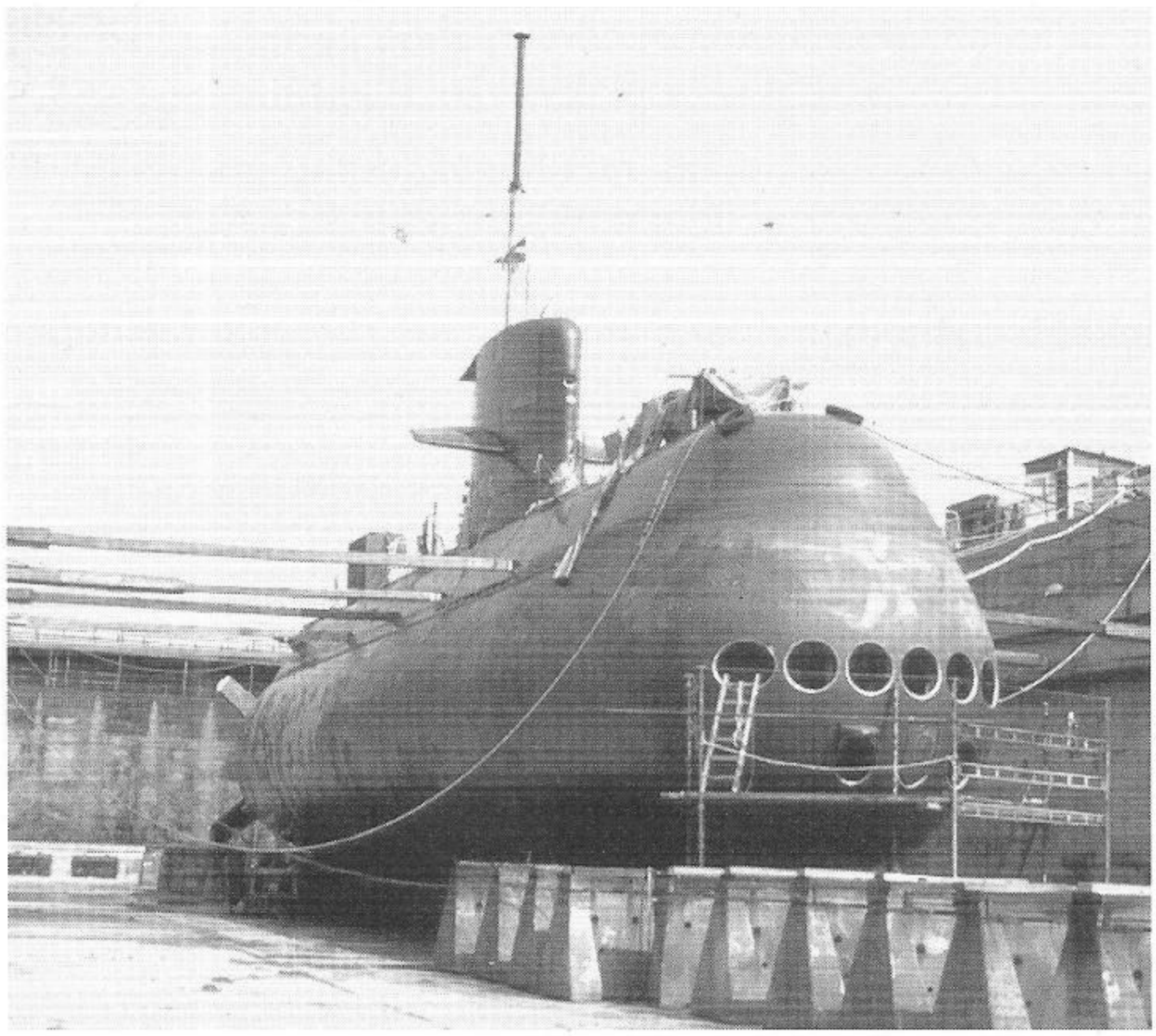
Six 533 mm (21 in), three 400 mm (15.75 in) tubes; swim-out discharge.
Total weapons carried, 12 × 533 mm; 6 × 400 mm.

TORPEDOES

Bofors Type 613 torpedo
The Type 613 is a homing, wire-guided, long-range torpedo for use against surface targets. It uses a thermal propulsion system with hydrogen peroxide/alcohol/water as propellants and is designed around a programmable digital computer which controls the homing system, communication with the launching fire-control system and the torpedo navigation system. The combination of homing and wire guidance is claimed to result in a very high hit probability, even at long firing ranges. The torpedo is equipped with both impact and computerised proximity fuzes, both of which can be controlled from the launching fire-control system.

Specifications
Length: 7.025 m (23.0 ft)
Diameter: 533 mm (21 in)
Weight: 1,765 kg (3,891 lb)
Warhead: 250 kg (551 lb)
Speed: 25 kts
Range: 16.20 n miles (30 km)
Propulsion: Energy produced by combusting alcohol with hydrogen peroxide as an oxidiser. Two-speed valve steam engine with gearbox

Manufacturer/Contractor
Bofors AB, Motala, Sweden.



Västergötland, *showing its six 533 mm and (below) three 400 mm torpedo tubes* (Kockums)

Bofors Type 431

The Type 431 is a 400 mm diameter, wire-guided torpedo with a homing system optimised for use against very silent submarines in shallow water, using an acoustic detector which distinguishes between target and disruptive noise. The combination of homing and wire guidance is claimed to result in a very high hit probability even at long firing ranges. The torpedo has three speeds selectable during its run to the target and is equipped with impact and computerised proximity fuzes, both of which can be controlled from the launcher fire-control system. The guidance wire communication link permits the launching craft to transmit orders to the torpedo, controlling speed, depth, course and target data, while the torpedo reports its position, speed, course and depth, homing systems parameters and target noise. If communications are lost, the torpedo's onboard computer calculates the expected target position, guides the torpedo to the predicted point of impact and initiates one of the several possible search patterns. The torpedo is also able to deliver a small anti-intruder charge.

Specifications

Length: 2.645 m (8.68 ft)
Diameter: 400 mm (15.7 in)
Guidance: Wire-guided
Homing: Active/passive
Weight: 350 kg (771.6 lb) (including battery and guidance wire)
Warhead: 45 kg (99.2 lb) shaped charge HE
Propulsion: Secondary silver-zinc (Ag/ZnO) battery 4.2/5.6 kW h
Speed: 15, 25, 35 kts
Performance: 10.8 n miles (20 km) at 25 kts

Manufacturer/Contractor

Bofors AB, Motala, Sweden.

MINES

These submarines can be fitted with an OMA (outboard mine attachment) strap-on mine 'girdle' carrying 48 mines, or they can carry up to 18 mines internally, in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

ARGOSystems AR 700-S5

The AR 700-S5 is a passive ESM and DF set for submarines, providing threat warning and direction capabilities over the frequency band 2-18 GHz.

Manufacturer/Contractor

ARGOSystems, Sunnyvale, California, USA.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

CelsiusTech NEDPS Mk 2

NEDPS (Näcken Electronic Data Processing System) Mk 2 was developed from the Mk 1 for use in 'Västergötland' class submarines and is essentially an improved version incorporating lessons learnt from operating the Mk 1. It is a fully integrated system, which acquires, processes and displays information for tactical evaluation and thus forms the basis for decisions regarding selected targets and torpedo guidance. The system includes complete hardware and software for controlling up to 12 wire-guided homing torpedoes simultaneously and the weapons are normally controlled fully automatically after firing, although manual override is available at all times.

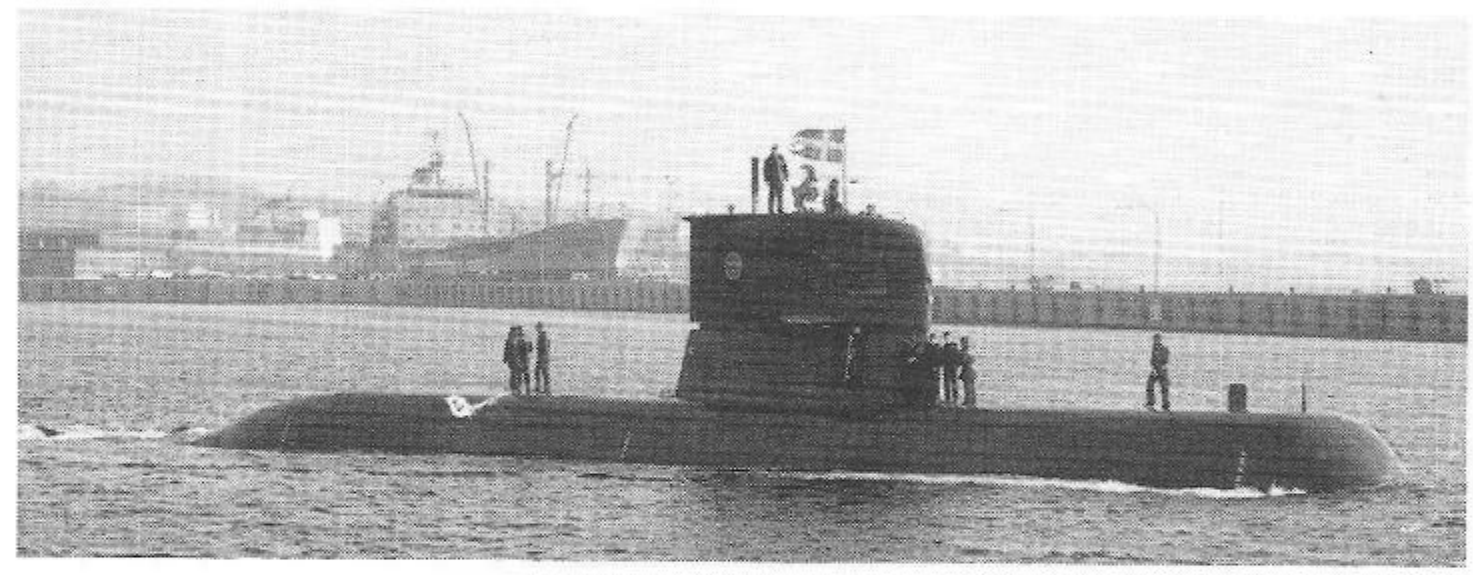
There are two Censor 932 computers, which are fed data from the various surveillance, weapon and navigation systems, which are then processed and presented to the operators. Tracking is automatic, with relevant fire-control data being calculated continuously.

The operational plot provides an extensive range of supplementary information, including: own submarine operational area; own submarine movements together with navigation reference points and times; operational areas for other submarines; minefields; coastal radar stations with radar parameters. The plot also displays up to 50 internal labelled targets, 10 target channels for target motioncalculated targets; 240 external (via datalink) targets with target numbers and identities; and 32 ESM lines. The tactical plot is used for the passive sonar TMA calculations on up to 10 targets simultaneously.

NEDPS also provides the Ship's Monitoring System (SMS) which monitors functions, such as propulsion, steering, depth-keeping, trim, and storage battery condition.

Manufacturer/Contractor

CelsiusTech Systems AB, Järfälla, Sweden.



Hälsingland *(Hgd), second of the four boat 'Västergötland' class (H & L van Ginderen Collection)*

General view of the highly automated command centre of a 'Västergötland' class submarine (Kockums)

PERISCOPE

Search/Attack
Pilkington Optronics CK 38 electro-optical.

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 2 Hedemora V12A/15 diesels; 1.62 MW (2,200 hp(m))
Generators: 2 Jeumont Schneider generators; 1.32 MW (1,800 hp(m))
Electric motor: 1 ASEA electric motor; 1,850 shp
Shaft: 1
Battery: 2 groups each of 84 Tudor cells

FURTHER INFORMATION

PROGRAMME

The design contract for these four submarines to replace the 'Draken' class was awarded to Kockums, Malmö, Sweden on 17 April 1978, followed by a construction contract on 8 December 1981. As is now the Swedish practice, the bow and stern sections were built by Karlskronavarvet at Karlskrona and then shipped to Kockums, Malmö who built the centre section and was responsible for final assembly.

DESIGN

These boats are of a single hull design, with an indexed, X-type rudder/after hydroplane. The hull is divided into two compartments by a watertight bulkhead and there is an escape chamber for the crew, which is situated aft of the sail and is designed to mate with the Royal Swedish Navy's 'URF' class rescue submersible. The hull is covered with an anechoic coating.

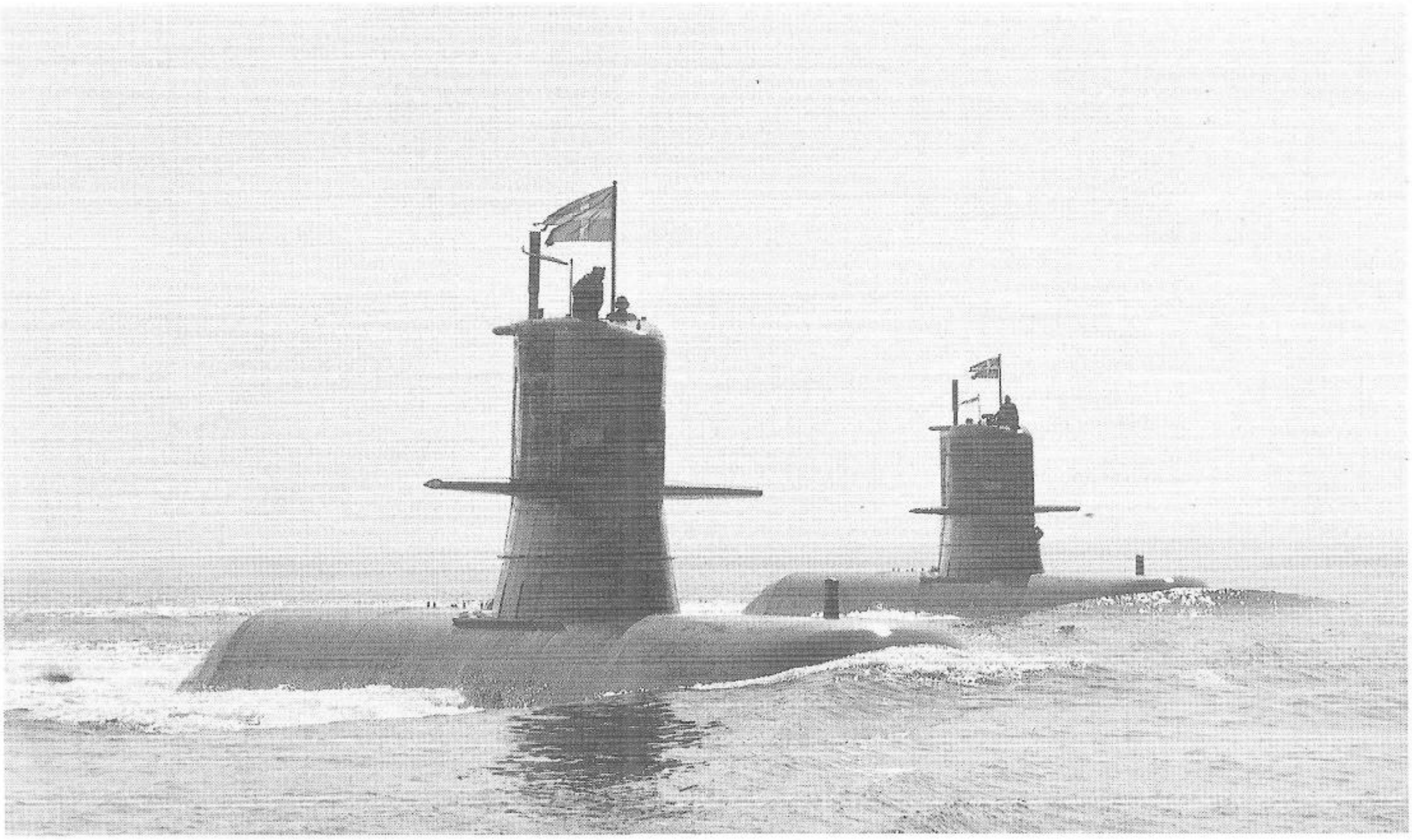
There are no less than nine bow torpedo tubes, six 533 mm and three 400 mm, together with one reload per tube. This represents one of the heaviest batteries ever installed in a submarine, let alone in a hull of this relatively small size. The tubes are arranged on two levels, with the six 533 mm tubes uppermost.

Close-up of the steering and engine control position in the control centre (Kockums)

MODERNISATION

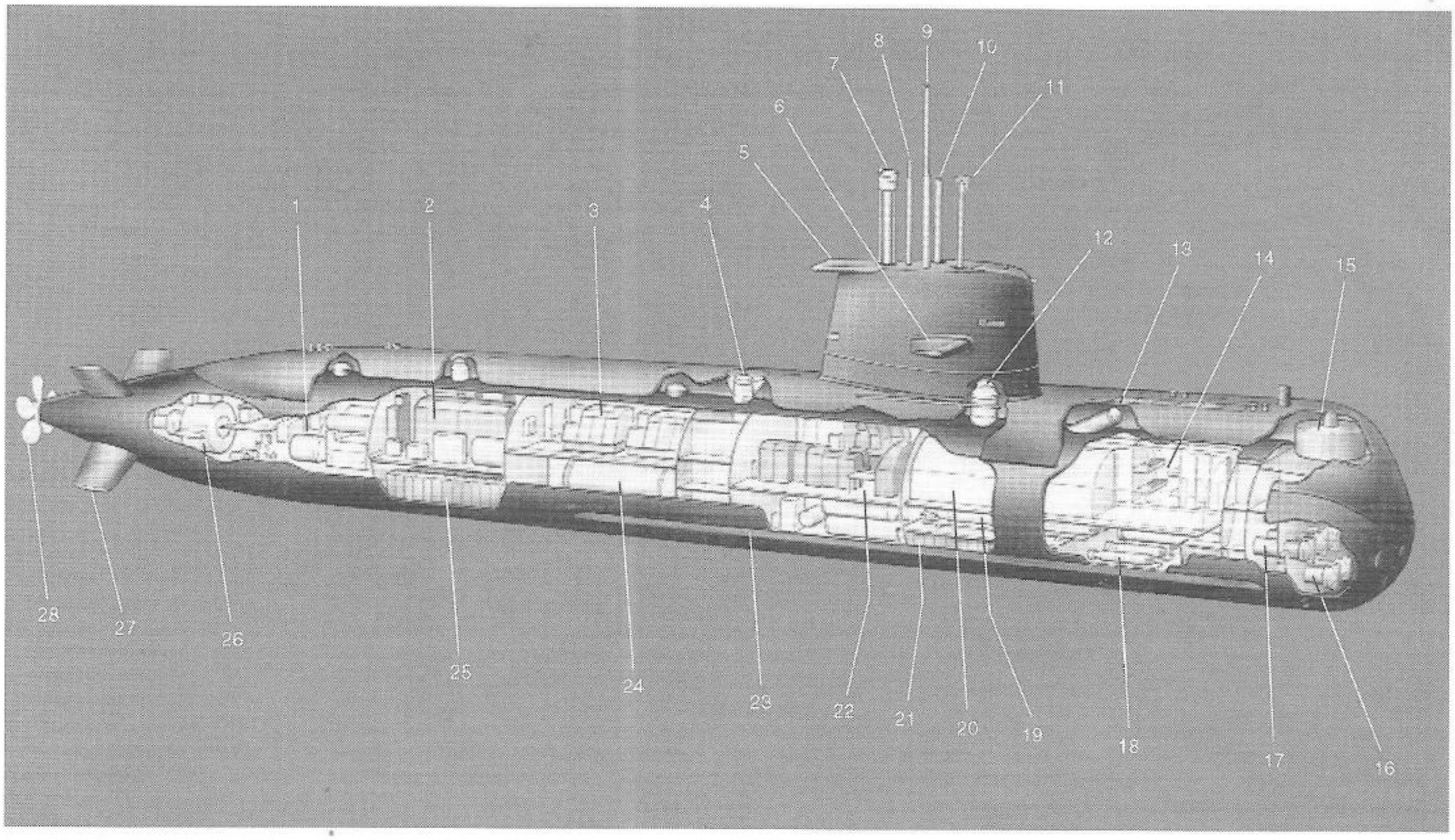
At one stage the navy considered the possibility of installing four vertical launch tubes for RBS-17 anti-ship missiles (a version of the Saab RBS-15 surface-skimmer). This was, however, eventually rejected, since the missiles were considered to be non-cost-effective in the context of submarine operations in the Baltic.

Another proposal was to retrofit these submarines with Stirling engines, but this appears to have been dropped.



Two boats of the 'Västergötland' class

GOTLAND



1 *Engine room* **2** *Propulsion control centre* **3** *Stirling generator sets* **4** *Escape trunk* **5** *Diesel exhaust* **6** *Forward hydroplanes* **7** *Air induction mast (snort)* **8** *Attack periscope* **9** *Communication mast* **10** *Search periscope* **11** *Radar mast* **12** *Main access trunk* **13** *Torpedo loading hatch* **14** *Crew cabins* **15** *Sonar array* **16** *400 mm torpedo tubes* **17** *533 mm torpedo tubes* **18** *400 mm torpedo stowage* **19** *533 mm torpedo stowage* **20** *Galley and mess* **21** *Forward battery compartment* **22** *Control room* **23** *Sonar array* **24** *Liquid oxygen (LOX) storage* **25** *After battery compartment* **26** *Propulsion motor* **27** *Fin* **28** *Propeller*

GENERAL SPECIFICATIONS

Country: Sweden

Class: GOTLAND
Type: A 19

Active: 1
Building: 2

Displacement:
surfaced: 1,240 t
submerged: 1,490 t

Dimensions
Length: 60 m (196.9 ft)
Beam: 6.2 m (20.34 ft)
Draught: 5.6 m (18.4 ft)

Speed:
surfaced: 11 kts
submerged: 20 kts (batteries); 5 kts (AIP)

Complement: 25

SUBMARINES

GOTLAND (Gld)	
Builder	Kockums, Malmö, Sweden
Laid down	20 Nov 1992
Launched	2 Feb 1995
Commissioned	Jul 1996

UPPLAND (Urd)	
Builder	Kockums, Malmö, Sweden
Laid down	14 Jan 1994
Launched	Jan 1996
Commissioned	May 1997

HALLAND (Hnd)	
Builder	Kockums, Malmö, Sweden
Laid down	21 Oct 1994
Launched	Sep 1996
Commissioned	Sep 1997

WEAPONS SYSTEMS

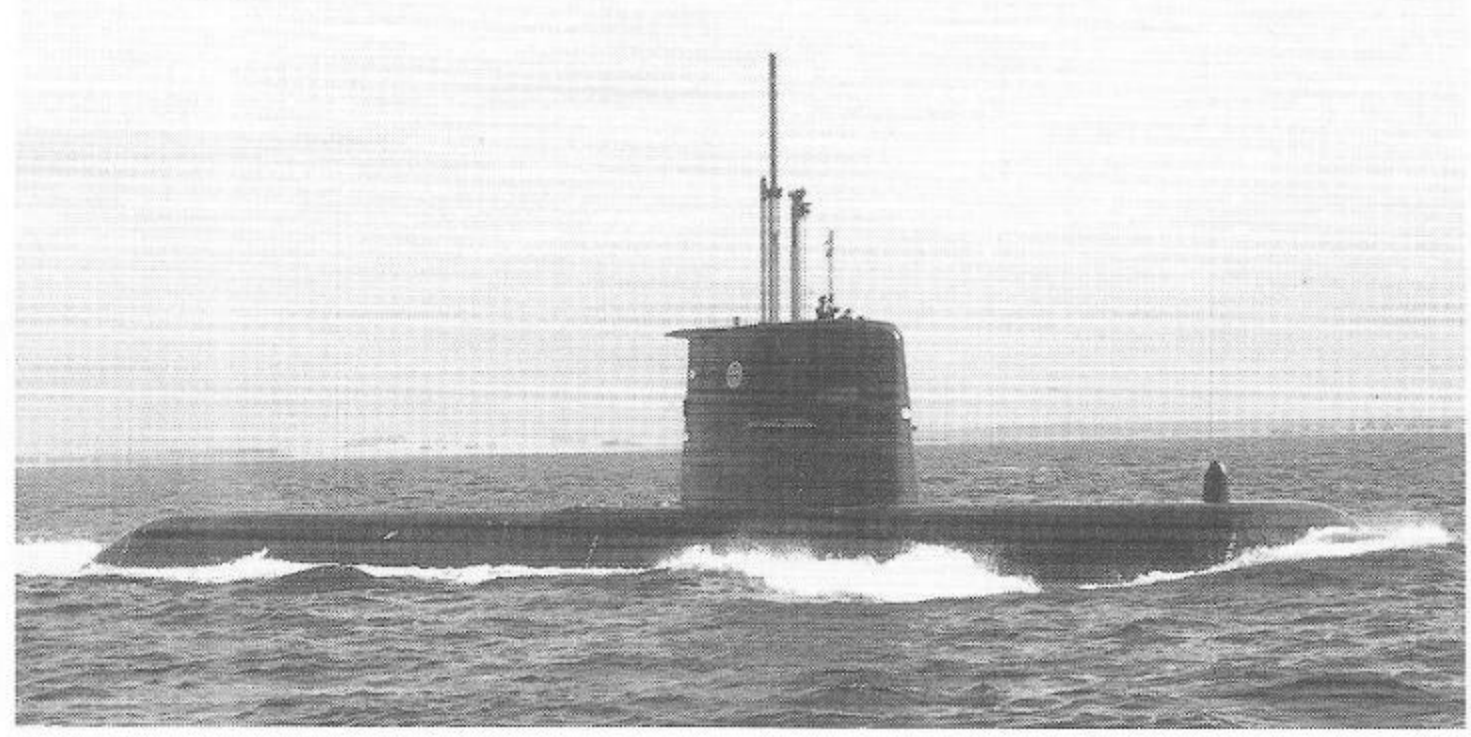
TUBES

Four 533 mm (21 in), two 400 mm (15.75 in) tubes; swim-out discharge.
Total weapon load, 12 × 533 mm, 6 × 400 mm torpedoes.

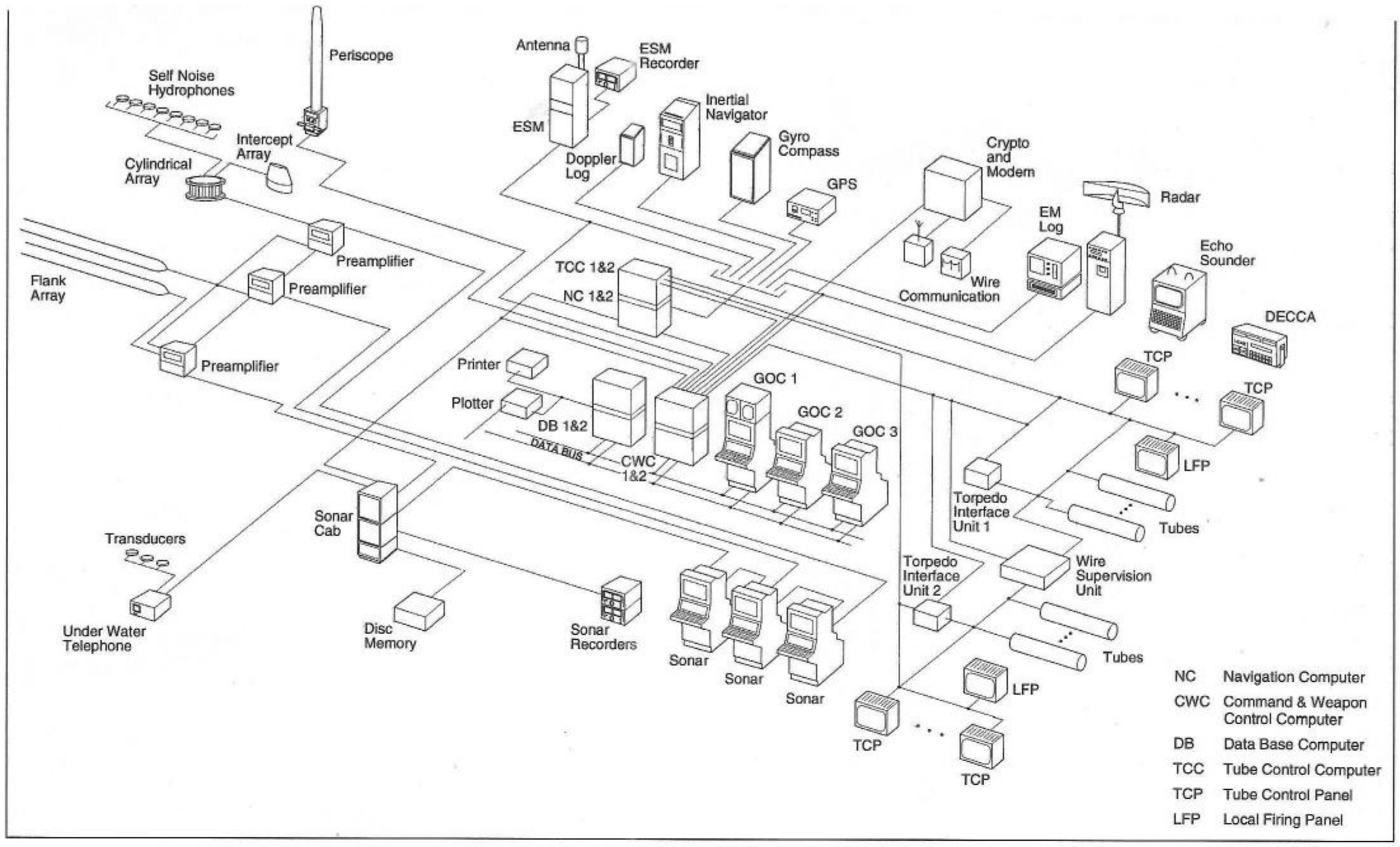
TORPEDOES

Bofors Torpedo 2000 heavyweight torpedo

The 'Gotland' class is the first to be armed with the new 533 mm, dual-purpose, heavyweight Torpedo 2000. The weapon is equipped with an advanced active/passive homing head and a wire guidance communication link, but in the event of communications being lost, the torpedo's onboard computer takes over full command and calculates the target's anticipated position before guiding the weapon to the predicted point of impact.



Gotland *in service* (Kockums)



'Gotland' class (A 19) combat system (Kockums)

Torpedo 2000 is propelled by a new, high-powered, pump-jet propulsion system driven by a new engine using a very high-energy fuel, derived from previous Bofors' high-test peroxide (HTP) systems. The system is wakeless and gives the weapon high speed and long range down to considerable depths, with low radiated noise levels.

Specifications

Length: 5.75 m (18.86 ft)
Diameter: 533 mm (21 in)
Weight: 1,314 kg (2,897 lb)
Speed: <50 kts
Range: <21.6 n miles (<40 km)

Manufacturer/Contractor

Bofors AB, Motala, Sweden.

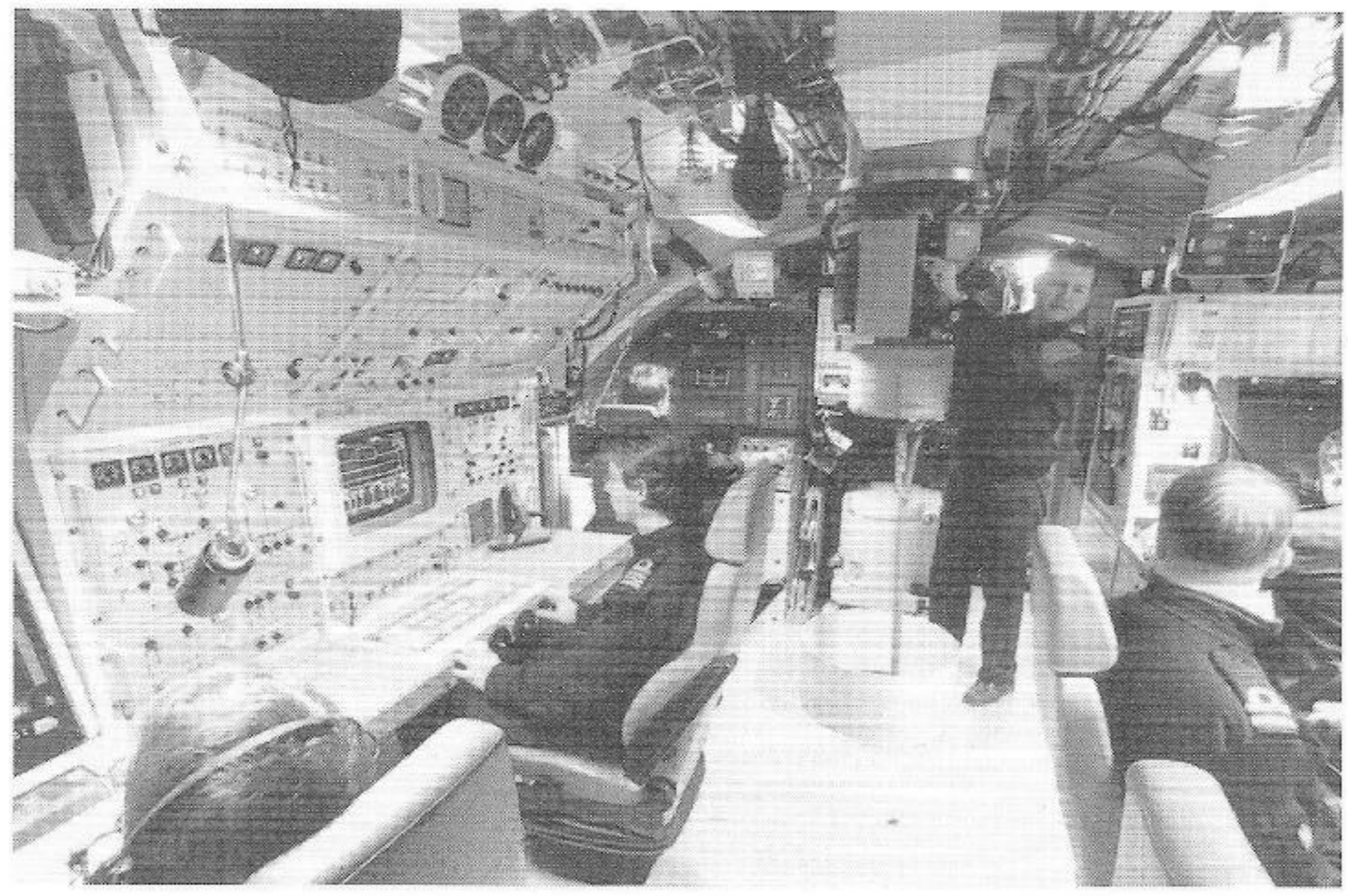
Type 43X2 multipurpose lightweight torpedo

The Type 43X2 torpedo uses a hydroacoustic homing system for the terminal guidance phase, which is virtually identical with that of the Torpedo 2000, using advanced signal processing carried out by the computer housed in the electronics module of the weapon. Three selectable homing modes are possible, active, passive or simultaneous active/passive and the weapon can track several targets simultaneously, classifying target signals and rejecting false signals both from the environment and from acoustic countermeasures.

The computer system monitors data gathered from onboard sensors and fed to it via the wire communication link, with more than 80 different types of message being exchanged which are used to control the weapon's parameters and targeting, and supervise homing procedures. If communications are lost, the onboard computer takes control, using the latest data received to compute search patterns.

The torpedo is fitted with a multifrequency hydroacoustic proximity fuze and an impact fuze. Advanced analysis of the received echoes enables waves, wakes and countermeasures from the hull of a ship to be discriminated. The torpedo uses three selectable speeds to optimise hit probability and minimise time from launch to strike.

There is also an 'anti-intruder' version of this torpedo, fitted with a small charge



Interior of a 'Gotland' class submarine showing the combat system in use (Kockums)

Specifications

Length: 2.80 m (9.19 ft)
Diameter: 400 mm (15.7 in)
Launch weight: 310 kg (683.4 ft)
Range: Approx 10.8 n miles (20 km) at 25 kts
Warhead: 45 kg (99.2 lb)
Propulsion: Secondary silver-zinc (Ag/ZnO) 4.2 kW h battery feeding a DC electric motor with gearbox

Manufacturer/Contractor

Bofors AB, Motala, Sweden.

MINES

These submarines can be fitted with a Kockums OMA (outboard mine attachment) strap-on mine 'girdle' carrying 48 mines, or they can carry up to 18 mines internally, in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thorn-EMI Manta S

Manta S is an advanced submarine ESM system which intercepts, analyses, classifies and identifies enemy radars at long range in the 2 to 18 GHz range. In addition, Manta provides information for tactical battle management, targeting and information gathering. Instantaneous warning enables the submarine commander to maintain a covert posture. Manta uses wide open ESM techniques, providing 360° coverage and 100 per cent probability of intercept. Intercepted signals are automatically analysed and identified by reference to a comprehensive library of known radar types.

Specifications
Frequency range: 2-18 GHz
Bearing accuracy: 6-10° (2° optional)
Sensitivity: −40 dBm
Dynamic range: 40-50 dB
Track capacity: 255 emitters simultaneously

Manufacturer/Contractor
THORN EMI Electronics Ltd, Sensors Group, Crawley, UK.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

CelsiusTech NEDPS Mk 2

NEDPS (Näcken Electronic Data Processing System) Mk 2 was developed from the Mk 1 for use in 'Västergötland' class submarines and is essentially an improved version incorporating lessons learnt from operating the Mk 1. It is a fully integrated system, which acquires, processes and displays information for tactical evaluation and thus forms the basis for decisions regarding selected targets and torpedo guidance. The system includes complete hardware and software for controlling up to 12 wire-guided homing torpedoes simultaneously and the weapons are normally controlled fully automatically after firing, although manual override is available at all times.

There are two Censor 932 computers, which are fed data from the various surveillance, weapon and navigation systems, which are then processed and presented to the operators. Tracking is automatic, with relevant fire-control data being calculated continuously.

The operational plot provides an extensive range of supplementary information, including: own submarine operational area; own submarine movements together with navigation reference points and times; operational areas for other submarines; minefields; coastal radar stations with radar parameters. The plot also displays up to 50 internal labelled targets, 10 target channels for target motion-calculated targets; 240 external (via datalink) targets with target numbers and identities; and 32 ESM lines. The tactical plot is used for the passive sonar TMA calculations on up to 10 targets simultaneously.

NEDPS also provides the Ship's Monitoring System (SMS) which monitors functions, such as propulsion, steering, depth-keeping, trim, and storage battery condition.

Manufacturer/Contractor
CelsiusTech Systems AB, Järfälla, Sweden.

RADAR

Navigation: Terma; I band.

SONARS

STN Atlas CSU 90

Sweden has selected STN Atlas' CSU 90 (CSU = Compact Sonar for U-boats) for the 'Gotland' class. This system comprises four main sonars:

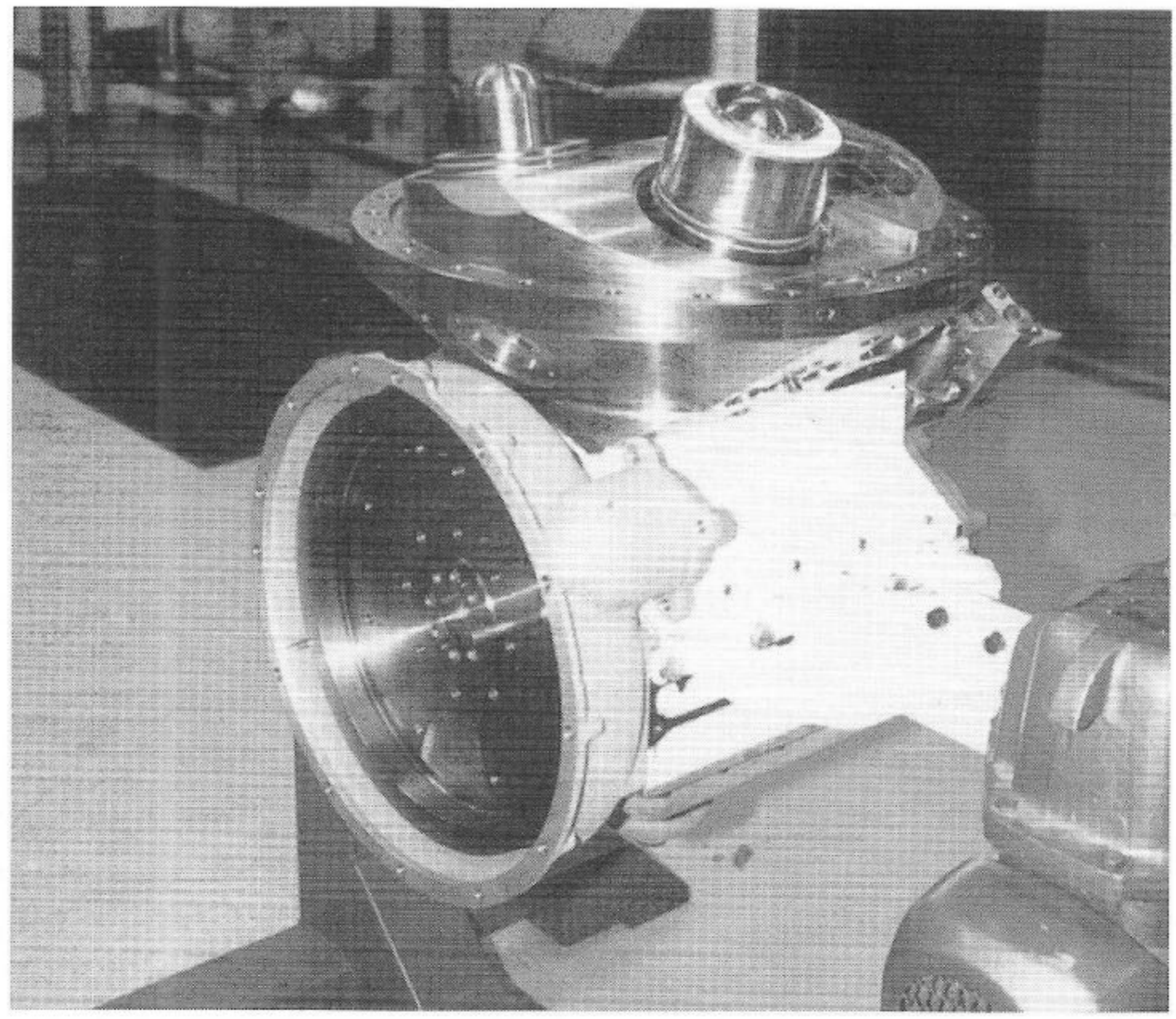
An attack panoramic passive sonar, consisting of a 2.8 m cylindrical hydrophone array, with full azimuth coverage. A Demon detection facility also uses the attack sonar array

An intercept passive sonar

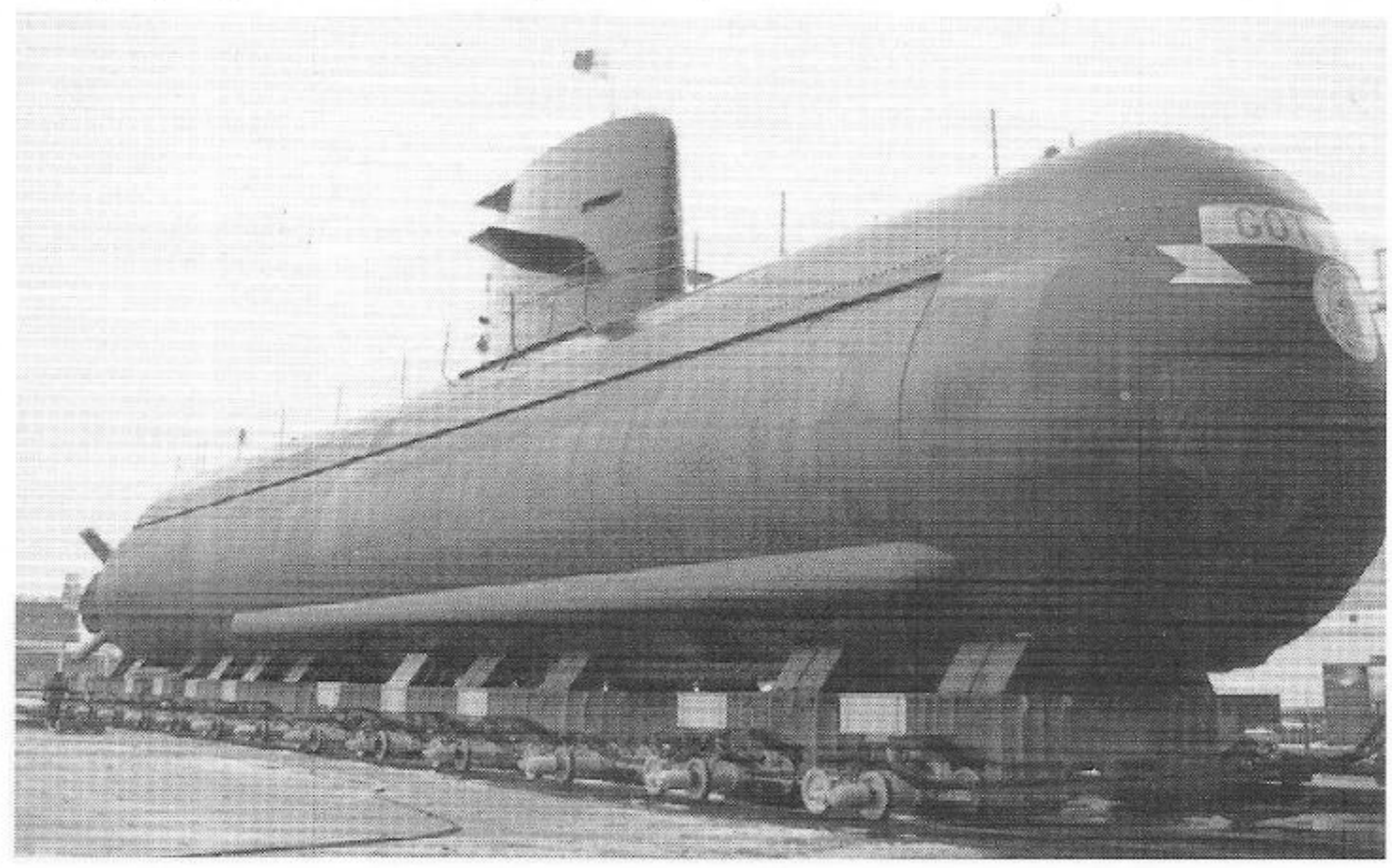
FAS 3 low-frequency flank array sonar, which is used for long-range detection

PRS 3 passive ranging sonar, consisting of six arrays, three on each side. These 15-stave arrays have a high-directivity index.

Any target detected by one of these sonars initiates an automatic process of data collection. CSU 90 is equipped with eight independent compound tracks, each providing the warfare system with a complete set of tactical data. Tracks are automatically incorporated in a compound track and each sensor can initiate a compound track. The total set of compound tracks comprises:



Stirling engine, pistons and crankcase (David Miller)



Gotland *immediately prior to launch. Note the FAS 3 sonar flank array along the lower part of the hull* (Kockums)

(a) eight ATT channels for the attack sonar
(b) eight ATT channels for the Demon path, each with eight ALTs
(c) the Target Motion Analyser (TMA) which controls eight compound tracks and generates a sonar tactical display
(d) TMA controls providing further manual tracks
(e) flank array sonar with eight ATT channels and eight MTs with eight ALTs each.

Extensions include a passive ranging sonar, a 'self-noise' analyser, acoustic passive classification, automatic warning channel, target motion analyser, a disk memory unit, plotting devices and simulation facilities. The disk memory unit allows all displays and sonar data to be recorded for subsequent analysis and for training. It also handles the data for comparison purposes of the sonar information processor and the classification file for the intercept sonar.

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen.

PROPULSION

Specifications
System: Hybrid (diesel-electric/air-independent)
Main Machinery: 2 MTU diesels
Air-independent engines: 2 Kockums V4-275R Mk 2 Stirling AIP; 150 kW max, 130 kW sustained
Electric motor: 1 Jeumont Schneider motor
Shaft: 1
Battery: Varta

FURTHER INFORMATION

PROGRAMME

The 'Gotland' class is of considerable significance as the first operational class to be constructed with an air-independent propulsion (AIP) system. The research contract for the new class was awarded to Kockums in October 1986 for a design to replace the Sjöormen class in the mid-1990s and a production order was placed on 28 March 1990.

DESIGN

The new design was required to meet a series of operational requirements, including: stealthy signature, high tolerance against shock caused by underwater weapons; long submerged endurance; substantial weapons load; and a high firing rate of guided and homing weapons against multiple targets. The result is a design which is essentially a progressive development of the 'Västergötland' class, but with the addition of a section containing two Stirling engines, as trialled in the Modified Näcken. Space has, however, been included for a second pair of Stirling engines, should they prove necessary.

Like its predecessors, the 'Gotland' class has a single periscope and the hull has an anechoic coating.

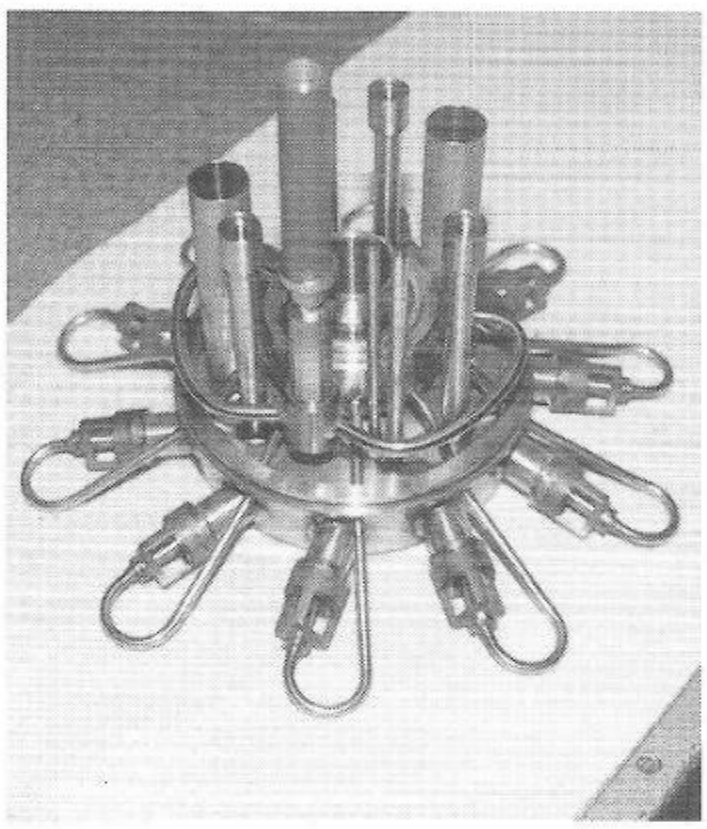
Planned life is 30 years

THE FUTURE

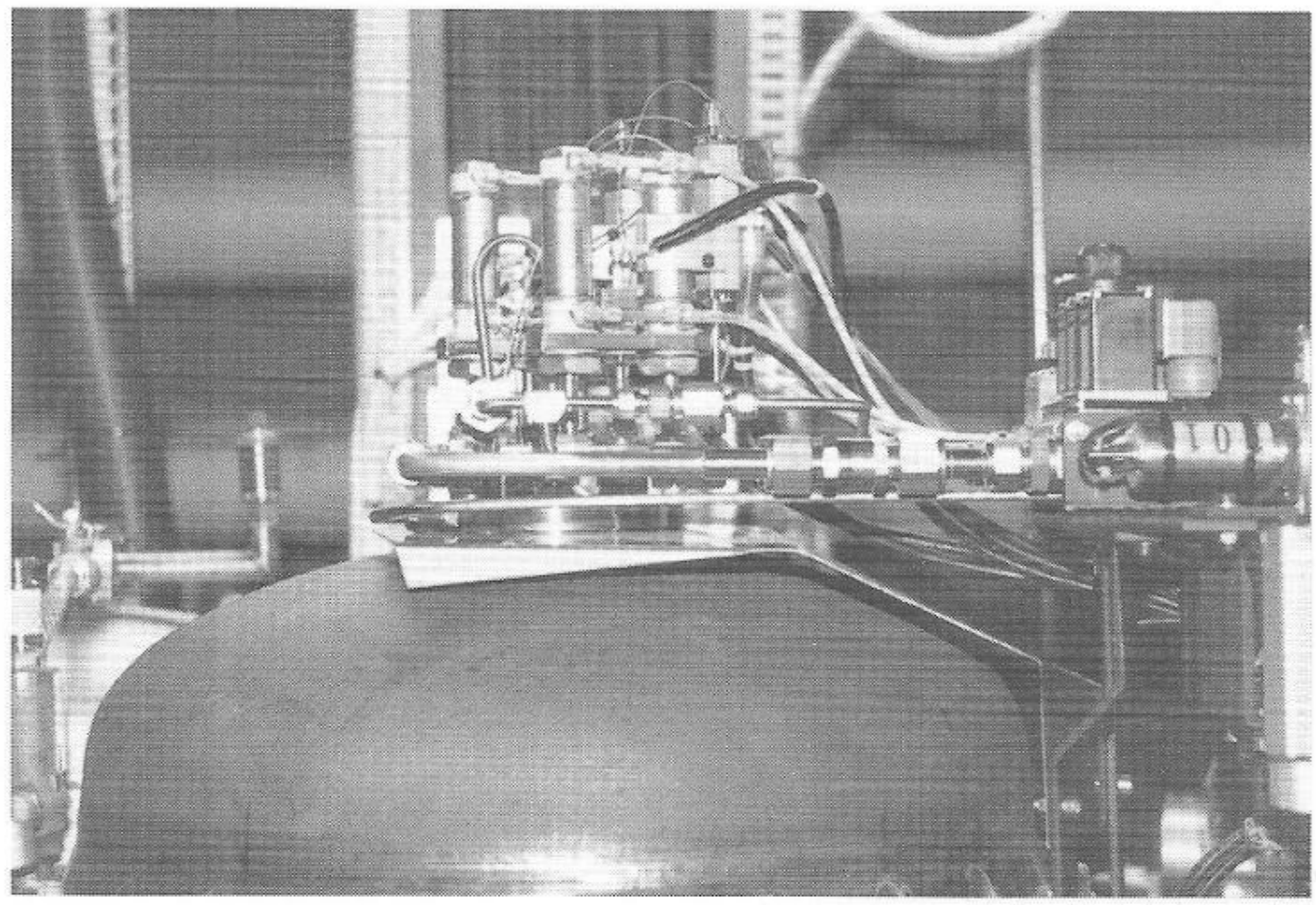
The next Swedish submarine project is already under way. Designated 'Submarine 2000' it is expected to enter service in (about) the year 2005. Various concepts are known to be under consideration, including a revolutionary 'flounder' design with a flattened top and bottom, and a low sail faired into the upper casing. Discussions are taking place with a view to making this a collaborative venture with the Norwegian and Danish navies — who both also need a new class of submarine in about the same timeframe — which, if it comes to fruition, would make it a 'Nordic' venture.

The Stirling air-independent propulsion system

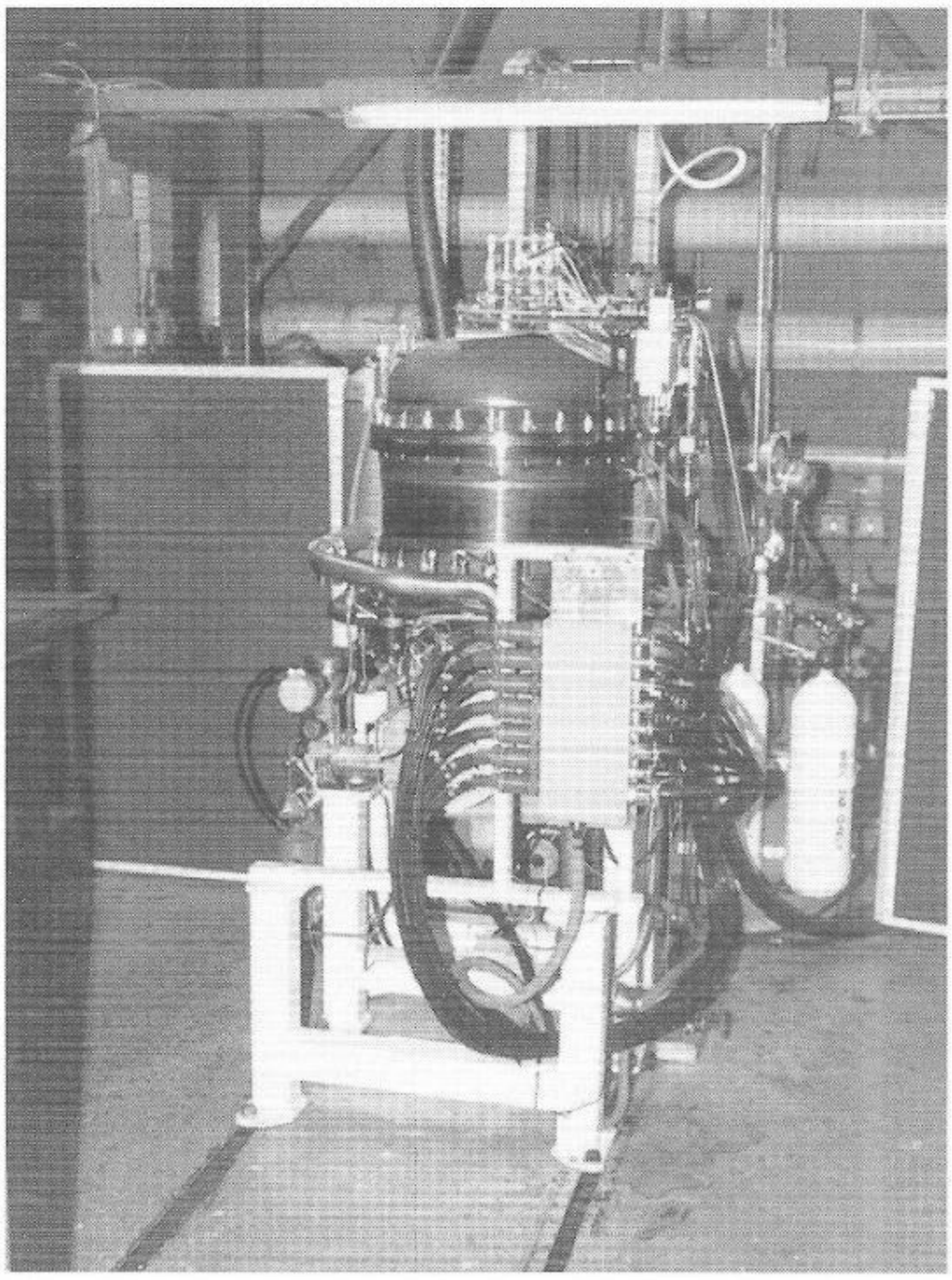
The Stirling principle is used to convert heat into mechanical work through a thermodynamic process. The Kockums V4-275R Mk 2 engine installed in Gotland has four cylinders, each with a swept volume of 275 cc per stroke, in a V-layout and connected to a single crankshaft. The engine operates at a constant 2,000 rpm and

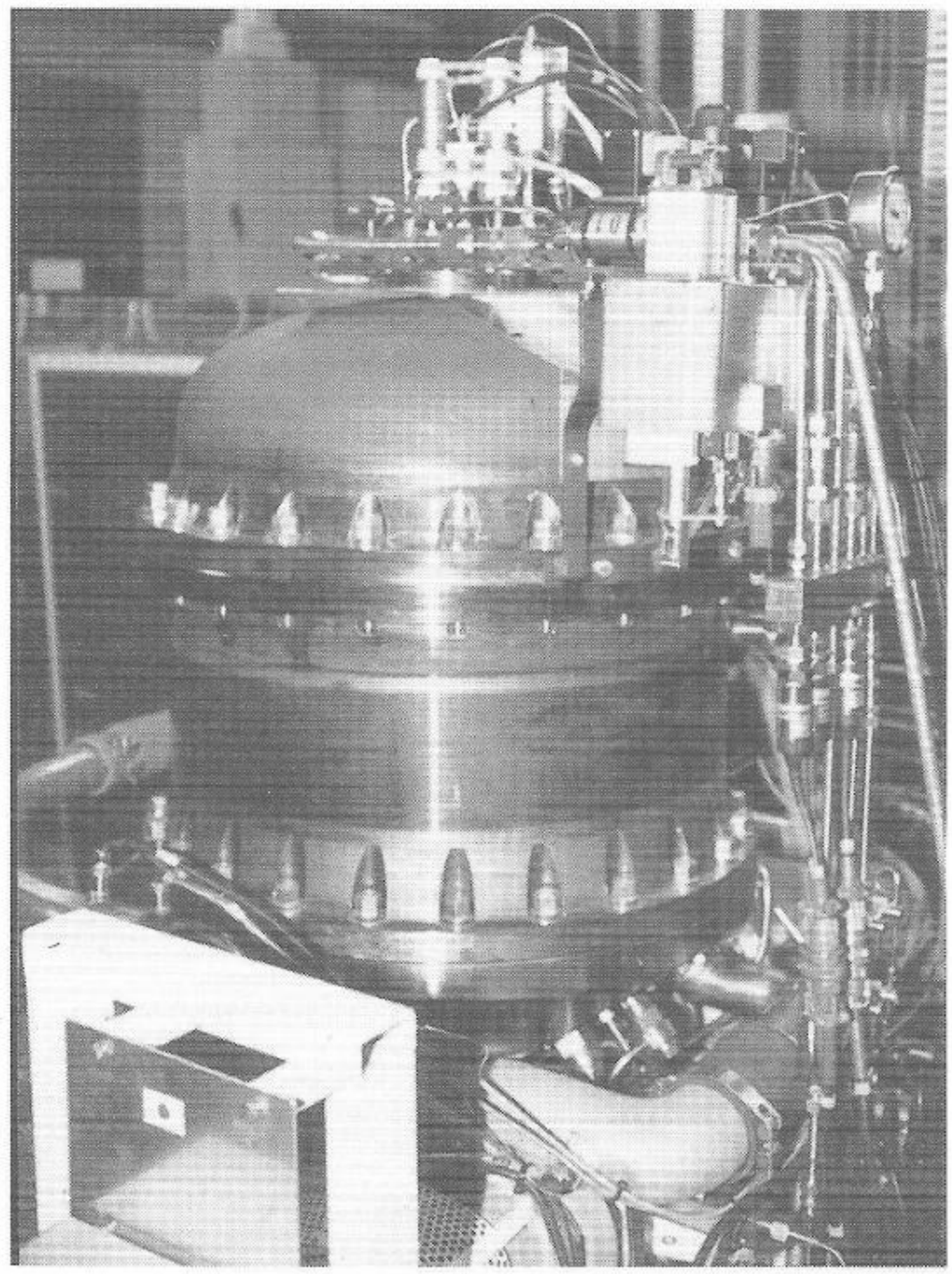


Ignition unit



Close-up of the head of the unit





The Stirling unit as installed in Gotland

is mounted on a double-elastic mounting within an acoustic shroud.

The Kockums Stirling engine uses standard diesel fuel from the submarine's normal fuel tanks and liquid oxygen (LOX), which is stored in cryogenic tanks in the lower level of the AIP section (that is, within the pressure hull). These are combined in a ratio of 4 parts diesel fuel to 1 part LOX and are burnt inside a circular combustion unit, with the resultant heat being passed through a heat exchanger to the working gas (helium) which expands over each piston when heated and contracts below each piston when cooled, thus driving the piston up and down, and rotating the crankshaft.

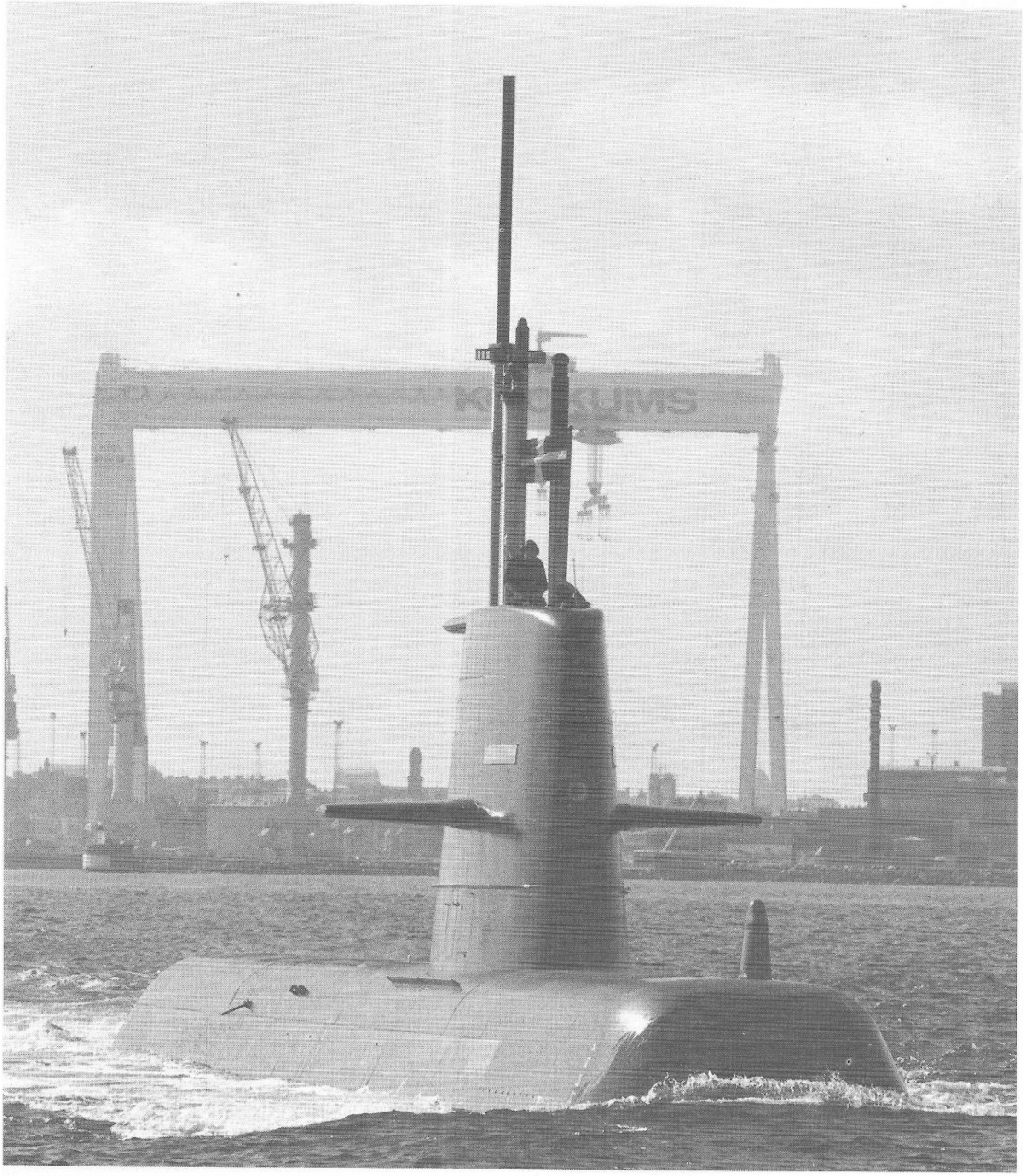
The engine module incorporates a cooling unit, which reduces the temperature of the exhaust gas from about 800°C to about 25°C. The gas then passes through an absorber, which mixes it with seawater, cooling it even further and it is then expelled, without bubbling, into the surrounding seawater. The internal pressure must obviously be higher than that of the surrounding seawater, for such expulsion to take place

The 'hotel load' aboard a submarine is the totality of the electrical power needed for the operational equipment (for example, computers, sonars and other sensors, pumps, compressors) and for life-support systems (for example, lighting, air conditioning, heaters and refrigerators, carbon monoxide scrubbers, ventilators and so on), plus, of course, the power needed to recharge the batteries. This 'hotel load' requirement is unavoidable and the power required for propulsion must be met from what remains of the capacity of the power source.

A typical figure for 'hotel load' is some 75 to 85 kW, which means that in a twin Stirling installation, for example, with each engine producing a rated 75 kW, some 65 to 75 kW remains to propel the submarine, which is sufficient to maintain a patrol speed of 3 to 5 knots. The only realistic method of increasing this is by installing further Stirling engines, and the Gotland was, in fact, originally intended to have three engines, but this was reduced to two on grounds of cost.

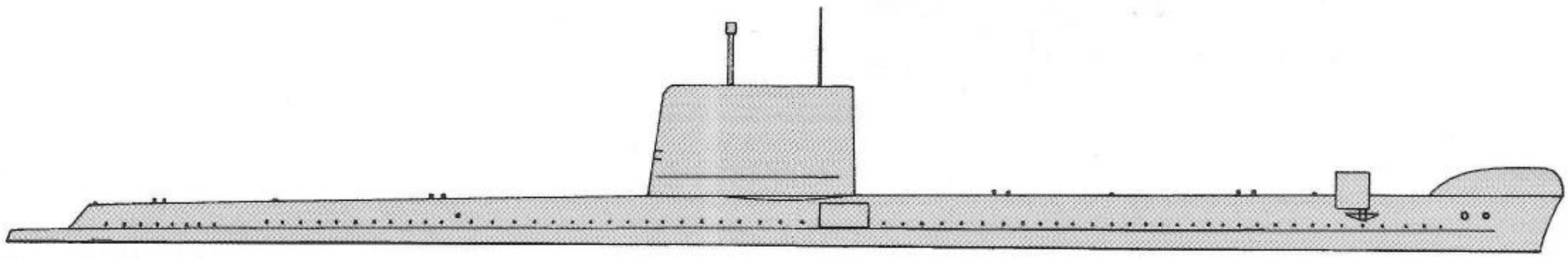
Endurance is mainly a factor of the amount of LOX carried, but it is claimed that a Stirling-powered submarine can remain on patrol for five to seven times longer than with batteries.

The Stirling engine is undergoing further development in Sweden. Meanwhile one Mk 1 engine has been on trial in Australia for several years and Japanese engine manufacturer Kawasaki has purchased two Mk 2 engines.



Gotland *departs the Kockums Yard at Malmö, Sweden where it was designed, built and fitted out* (Kockums)

OBERON



Oberon (Ian Sturton)

OVERVIEW

The British-designed and -built 'Oberon' class remains of importance, with 10 still in service in four navies, although the numbers are diminishing. The Porpoise was the first British post-war submarine design and eight were built, entering service between 1958 and 1961. The design was heavily influenced by the German Type XXI, whose advanced performance was such that it could have gravely influenced the naval war had the German Navy managed to get it into service in time.

The 'Porpoise' class was required to have a submerged speed of 17 knots for 20 minutes and a maximum diving depth of 200 m (650 ft). It was designed to meet the threat posed by Soviet submarines and was successful, with eight being built, but a number of detailed improvements led to an even better design: the 'Oberon' class.

The Oberon was a conventional, 1950s, double-hull design, with a pressure hull constructed of high-yield UKE steel, with lightweight materials used for the casing and sail. The design met all its operational requirements and, despite its twin propellers, proved to be exceptionally quiet.

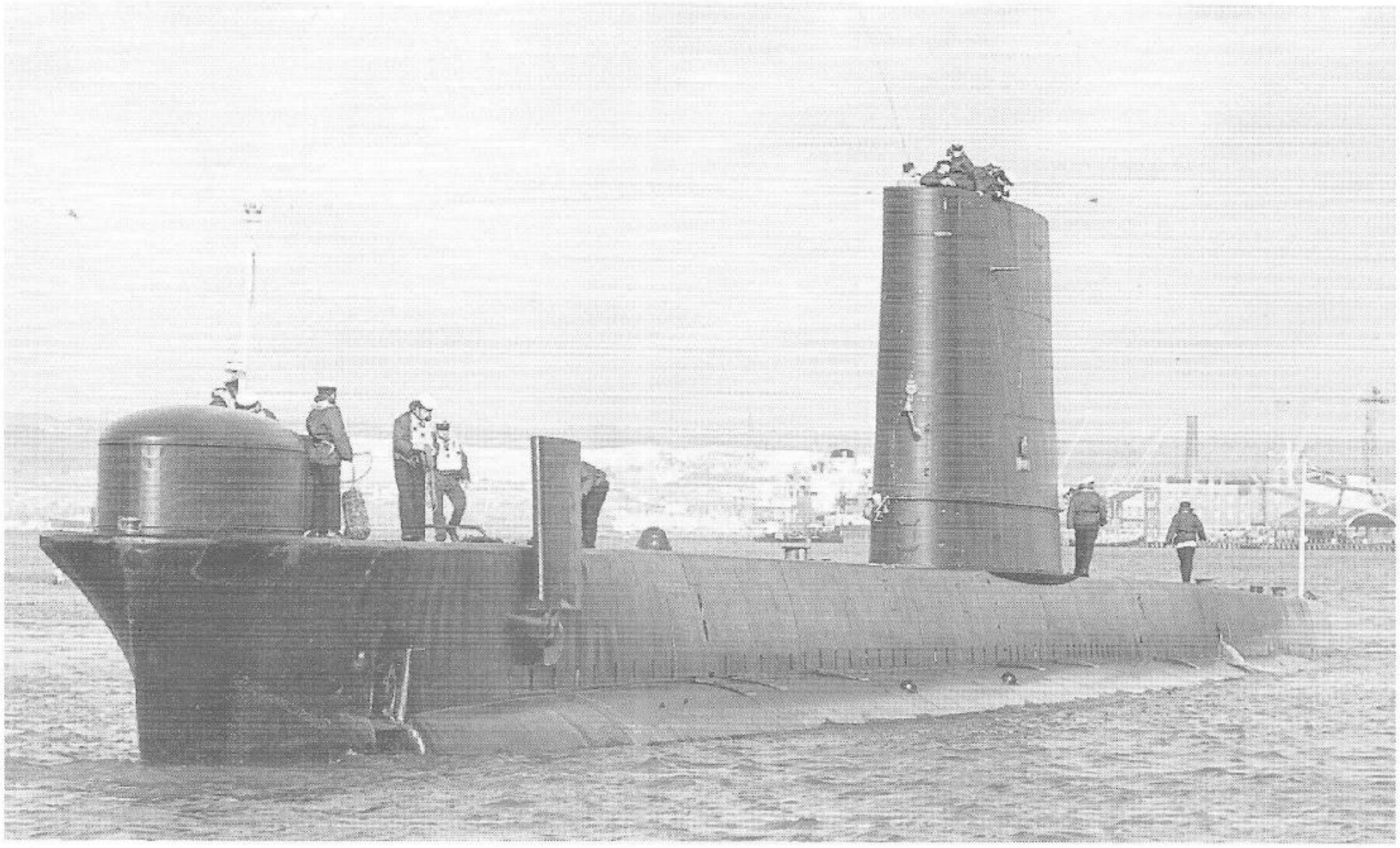
More British submarines of the 'Oberon' class than any other have been built since the Second World War, with 13 built for the British Navy and 14 exported, all of which were built in British yards (see table). Those British Oberons were, in fact, the last new-build British submarines to be exported, no further orders for any type having been received.

Navy	Number built	Entered service	In service January 1997	Remarks
Australia	6	1969-78	2	Last two will strike in 1998
Brazil	3	1973-77	3	
Canada	3	1965-68	3	a. Replacement uncertain b. Ex-*Olympus* is used as a harbour trainer
Chile	2	1976	2	A replacement is being sought
UK	13	1960-67	0	Last was stricken in 1992
	27		**10**	

As built, the 'Oberon' class was fitted with six 533 mm (21 in) tubes in the bows for conventional heavyweight torpedoes, the British Navy, for example, using Mk VIII torpedoes. There were also two shorter 533 mm (21 in) tubes in the stern which used the specially developed Mk XX(S) anti-ship torpedo, although this was replaced by the Mk XXIII, wire-guided, anti-submarine torpedo from about 1970 onwards.

In the British boats, when the Tigerfish heavyweight torpedo replaced the venerable Mk VIII, the use of the stern tubes was discontinued, but the position among the export submarines still in service differs between navies. In the Australian boats the stern tubes have been completely removed, while in the Canadian and Chilean boats the tube mechanism is still fitted, but they have been blanked off and are no longer used. Only in the Brazilian boats are the tubes still in use, where they are used to launch Honeywell Mk 37 Mod 2 torpedoes. All remaining boats have had several major refits and have had their equipment repeatedly upgraded.

The British boats were retired between 1987 and 1983 and various attempts were made to sell at least some of them overseas, with Egypt being one of the possible purchasers. Only one minor success was achieved, with the sale of two to Canada. One (ex-*Olympus*) is used as a non-operational harbour trainer, while the second (ex-*Osiris*) is used as a source of spares for the three operational boats.



A classic British post-Second World War diesel-electric submarine; the 'Oberon' class boat, HMS Opossum. *27 of these submarines were built for five navies, but only ten now remain in service* (UK MoD)

OBERON, AUSTRALIA

GENERAL SPECIFICATIONS

Operator: Australia
Type: Oberon

Class: ONSLOW

Bought: 6
In service: 2

Displacement:
surfaced: 2,030 t
submerged: 2,410 t

Dimensions
Length: 90 m (295.2 ft)
Beam: 8.1 m (26.5 ft)
Draught: 5.5 m (18 ft)

Speed:
surfaced: 12 kts
snorting: 11 kts
submerged: 17 kts
Range, surfaced: 9,000 n miles at 12 kts

Complement: 64 (8 officers)

SUBMARINES

ONSLOW (60)

Builder	Scott Lithgow, Greenock, UK
Laid down	4 Dec 1967
Launched	3 Dec 1968
Commissioned	22 Dec 1969

ORION (61)

Builder	Scott Lithgow, Greenock, UK
Laid down	6 Oct 1972
Launched	16 Sep 1974
Commissioned	15 Jun 1977

OTAMA (62)

Builder	Scotts Lithgow, Greenock, UK
Laid down	25 May 1973
Launched	3 Dec 1975
Commissioned	27 Apr 1978

WEAPONS SYSTEMS

ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Sub-Harpoon

All Australian boats were fitted to handle and launch Sub-Harpoon as part of the 1985-89 Defence programme. Block 1C includes a number of options, including the ability to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses, or to approach the target indirectly, using up to three preselected waypoints. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 kg)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)

Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

There are six 533 mm (21 in) tubes; bow; high-pressure air discharge.
Total weapon load, 20.

TORPEDOES

Mk 48 Mod 4

The Mk 48 torpedo is an anti-submarine and anti-ship weapon, capable of operating in wire-guided, acoustic and non-acoustic modes, with the acoustic modes being either active or passive. Externally the Mk 48 is a long slim cylinder with a flat nose and four fins, one of which contains the wire dispenser. The wire link is two-way, enabling data from the weapon's homing and guidance system to be relayed to the submarine fire-control system, so that the weapon can be guided more accurately from the submarine.

Specifications
Length: 5.84 m (19.16 ft)
Diameter: 533 mm (21 in)
Weight: 633 kg (1,395 lb)
Range: 21 n miles (38 km) at 55 kts or 27 n miles (50 km) at 40 kts
Max depth: 760 m (2,490 ft)
Max speed: 55 kts
Warhead: 267 kg (589 lb)

Manufacturers/Contractors
Hughes Aircraft Company, Ground Systems Group (prime).
Westinghouse Electric Corporation (second source).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Mavis

AWA Mavis radar warning system.

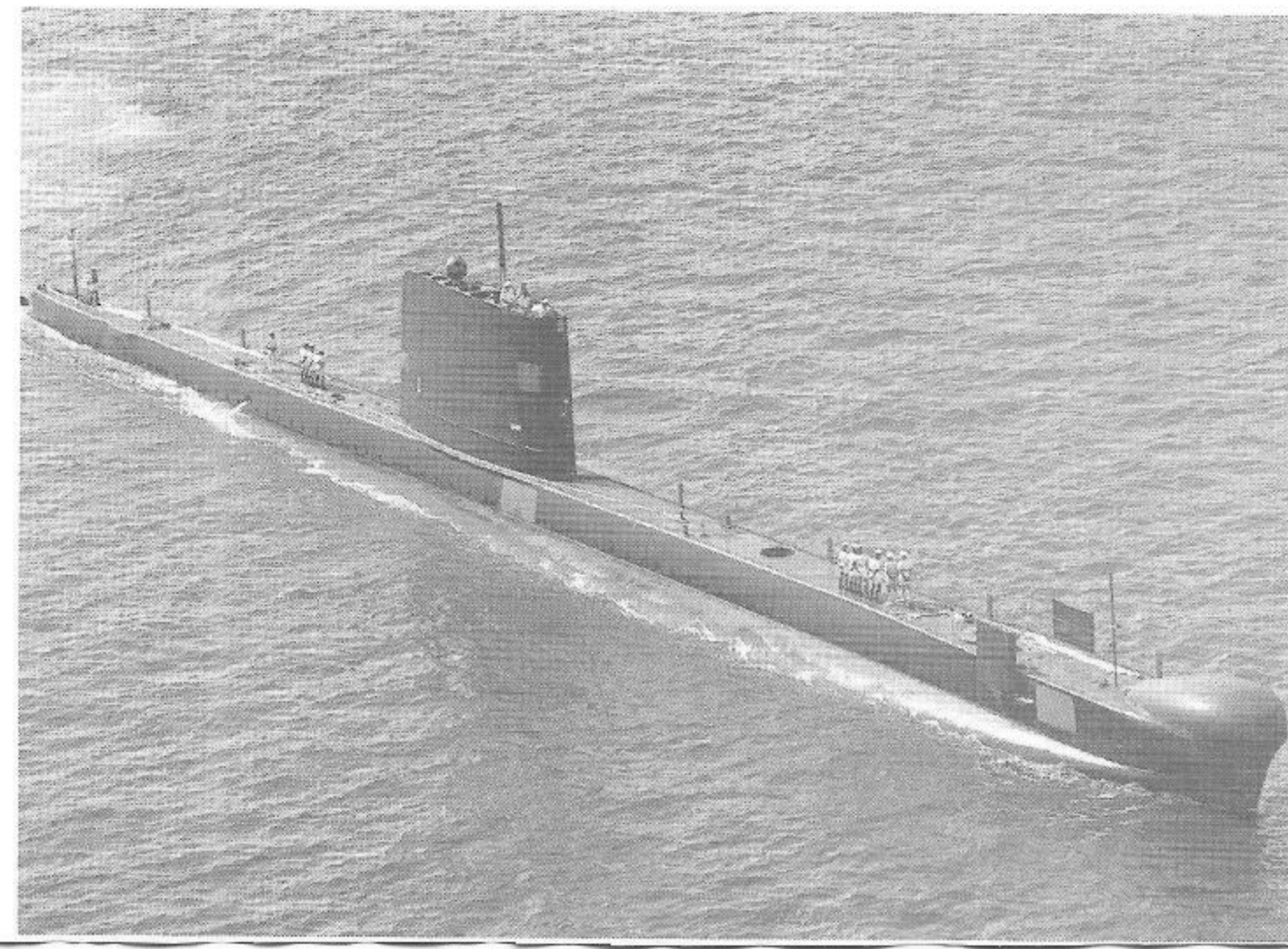
Manufacturer/Contractor
AWA Defence industries, Elizabeth, South Australia, Australia.

DECOYS

SSDE Mk 2/4

Two 102 mm SSDE (Submarine Signal and Decoy Ejectors) are installed: Mk 2 forward, Mk 4 aft. These are used to launch decoys and communications buoys.

Manufacturer/Contractor
Strachan & Henshaw, Bristol, UK.



The two remaining boats, Onslow *and* Otama, *are identical to the recently stricken* Ovens, *seen here. Two of the three starboard PUFFS arrays can be clearly seen on the side of the upper casing* (J Mortimer)

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

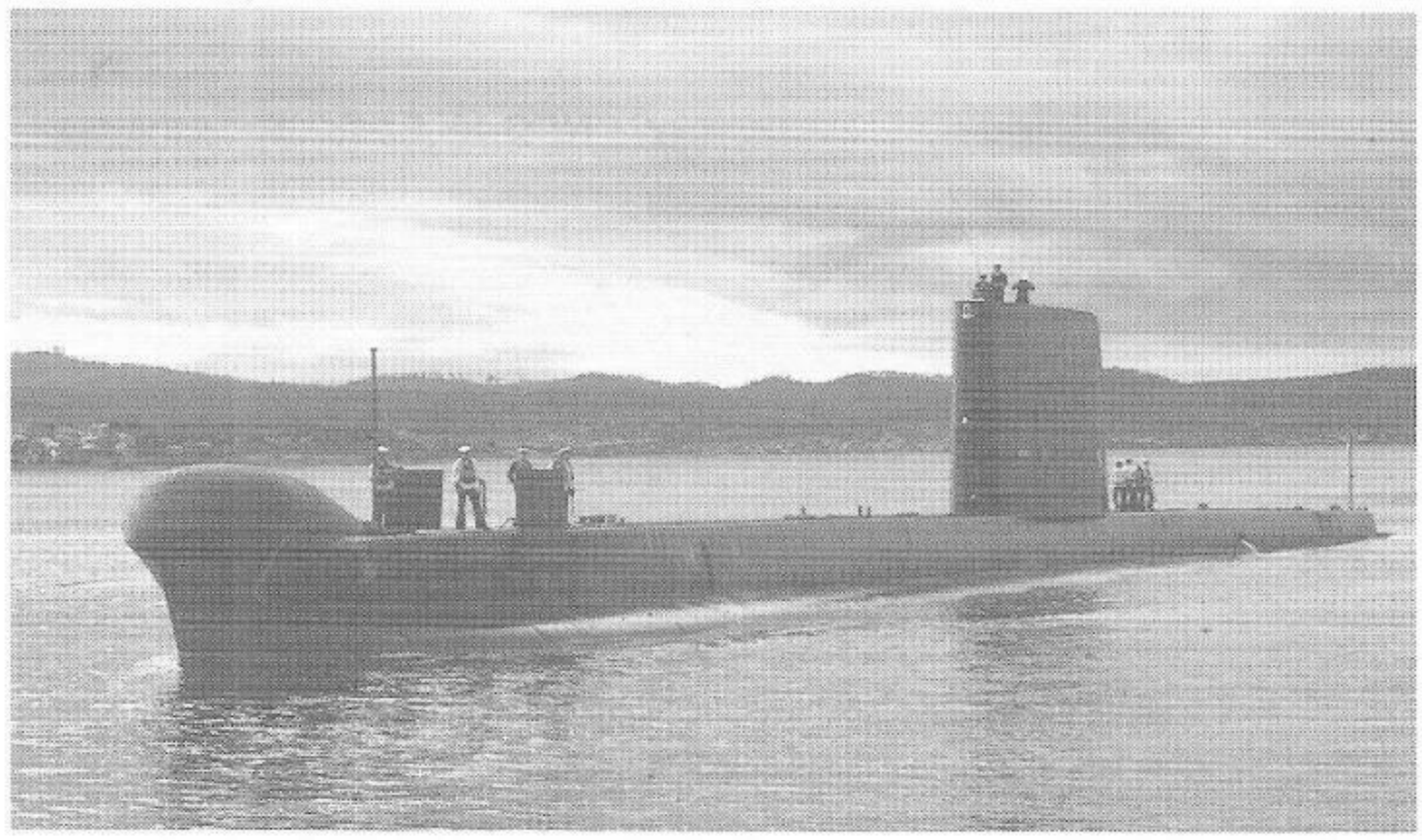
Singer-Librascope SFCS Mk 1 Mod 1

Submarine Fire-Control System Mk 1 (SFCS Mk 1) was produced in the late 1970s by Singer-Librascope and installed in the Australian 'Oberon' class submarines, entering service in February 1980 with the recommissioning of HMAS *Oxley*. It was claimed at the time to be the first digital submarine fire-control system and is a mainframe architecture system based upon the 16-bit AN/UYK-20 mini-computer, which has a 64 k memory and can store up to 30 minutes of data from a sonar channel or a sonar assignment unit. It is complemented by a Librascope CL 107MA 409 k 16-bit memory mass memory unit with a 409 k memory which is used to store track data as well as for other digital data. The electronics circuit cards are US Navy Standard Electronic Modules and programming uses CMS-2 language software. SFCS Mk 1 can detect up to 20 targets, can track four and can engage two. TMA is conducted upon any four of the nine sonar channels with measurements every second then being averaged over 20 second intervals.

The Australian submarines are fitted with SFCS Mk 1 Mod 1, an upgraded Mod 0 system for use with the US Mk 48 Mod 4 torpedo and Sub-Harpoon missiles.

Manufacturers/Contractors

Loral-Librascope, Glendale, California, USA (prime).
Rockwell Systems Australia, North Ryde, NSW, Australia (Australian version)



An Australian 'Onslow' class submarine. The streamlined dome in the bows houses the passive array for the STN Atlas 34-1 passive array. Also apparent in this view are the long, narrow hull; the very tall sail (made of plastic); and the vertically folding forward hydroplanes (Jane's/H M Steele)

RADAR

Specifications

Type 1006 navigation radar
Role: Navigation
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 30 dB
Pulsewidth: 0.08/0.25/0.75 µs
Pulse repetition frequency: 725-1,000/1,450-2,000 pps
Scan rate: 26 rpm

Manufacturer/Contractor

Kelvin Hughes, Ilford, Essex, UK.

SONARS

STN ATLAS CSU 3-41

CSU 3-41 is a fast-scanning medium-range, medium-frequency, active/passive sonar, which can be used as a long-range passive device, an intercept sonar and as an underwater telephone. The passive array is housed under a streamlined dome atop the bows and the active transducer is in the sail.

Manufacturer/Contractor

STN Atlas Elektronik GmbH, Bremen, Germany.

Graseby Marine Type 2007

Type 2007 entered service in 1971 and uses steerable beams to detect and track hostile submarines. The search beams listen at frequencies between 1 and approximately 3 kHz to detect sounds caused by propeller cavitation, nuclear cooling pumps or turbine reduction gears. The array consists of 24 hydrophones evenly spaced along both sides of the hull.

Manufacturer/Contractor

Graseby Marine (Graseby Dynamics Ltd), Watford, UK.

GEC-Marconi Karriwarra

Karriwarra is a thin-line towed array, based on original work carried out by the Australian Defence Science and Technology Organisation (DSTO) and is a digital version of the analogue system, known as the Self-Streaming Towed Array Sonar (SETAS), which has been in continuous service with the 'Oberon' class submarines of the Royal Australian Navy for seven years.

Karriwarra streamers are exceptionally robust and durable, with acoustic performance better than equivalent to oil-filled streamers. The Karriwarra construction utilises a combination of tough buoyancy-controlled polymers and is modularised into functional sections joined by titanium electromechanical connectors and is easily repairable.

Manufacturer/Contractor

GEC-Marconi Systems, Meadowbank, New South Wales, Australia.

Sperry MicroPUFFS

MicroPUFFS is a long-range, passive ranging system, which was developed specifically for the Australian Navy by Sperry in the mid-1970s. As its name suggests, it was derived from the US Navy PUFFS (Passive Underwater Fire-control Feasibility Study) hardware. There are three baffled arrays of hydrophones mounted on each side of the submarine, connected to a display control console, which utilises an analogue processor, digital processor and AN/UYK-26 computer.

MicroPUFFS provides automatic target tracking of up to four simultaneous targets, instantaneous and continuous ranging solution, fire-control range and bearing output, and secure operation. The two arrays each form five beams covering a 150° sector and the basic technique is signal enhancement by cross correlation of the signals received at the arrays with conversion of two measured time differentials into bearing and range data.

Manufacturer/Contractor

UNISYS Corporation, Defense Systems, Great Neck, New York.

PERISCOPES

Search: CK 24.
Attack: CH 74.

Manufacturer/Contractor

Pilkington Optronics, St Asaph, Clwyd, UK.

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 2 Admiralty Standard Range (ASR) 16 VVS-ASR1 diesels; 2.74 MW (3,680 hp)
Electric motors: 2 AEI; 4.48 MW (6,000 hp)
Shafts: 2
Battery: 2 groups, each of 224 cells; 5,000 Ah at 1 h rate, 7,420 Ah at 5 h rate

FURTHER INFORMATION

PROGRAMME

The Australian order was placed in 1963 for four submarines, all to be constructed in the UK. Two more ordered in October 1971 and the six boats joined the fleet between 1967 and 1978. Four of these have already been stricken and the remaining two, *Onslow* and *Otama,* are both scheduled to be stricken in 1998.

MODERNISATION

Between October 1977 and October 1985 all submarines of the class were given a mid-life modernisation at the Vickers yard at Cockatoo, Australia. Sub-Harpoon was fitted in 1985-86 and the two short stern tubes have been removed.

OPERATIONAL

All of the class have been used for trials of the Karriwarra towed array.

DEPLOYMENT

Both remaining boats are stationed at Fleet Base West.

OBERON, BRAZIL

GENERAL SPECIFICATIONS

Operator: Brazil
Type: Oberon

Class: HUMAITA

Bought: 3
In service: 3

Displacement:
surfaced: 2,030 t
submerged: 2,410 t

Dimensions
Length: 90 (295.2 ft)
Beam: 8.1 m (26.5 ft)
Draught: 5.5 m (18 ft)

Speed:
surfaced: 12 kts
snorting: 10 kts
submerged: 17 kts
Range, surfaced: 9,000 n miles

Complement: 70 (6 officers)

SUBMARINES

HUMAITA (S 20)

Builder	Vickers, Barrow-in-Furness, UK
Laid down	3 Nov 1970
Launched	5 Oct 1971
Commissioned	18 Jun 1973

TONELERO (S 21)

Builder	Vickers, Barrow-in-Furness, UK
Laid down	18 Nov 1971
Launched	22 Nov 1972
Commissioned	10 Dec 1977

RIACHUELO (S 22)

Builder	Vickers, Barrow-in-Furness, UK
Laid down	26 May 1973
Launched	6 Sep 1975
Commissioned	12 March 1977

WEAPONS SYSTEMS

TUBES

There are eight 533 mm (21 in) tubes; six bow, two stern.
Total weapon load, 24 (20 Tigerfish plus four Mk 37).

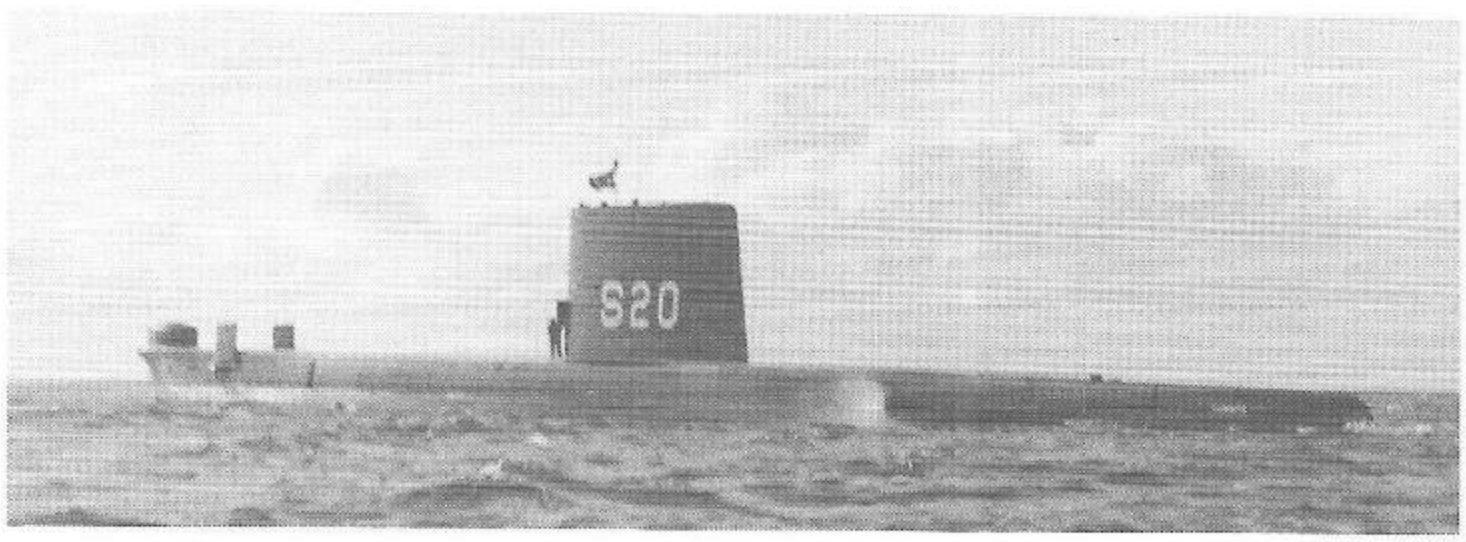
TORPEDOES

GEC-Marconi Mk 24 Tigerfish

Tigerfish uses the passive mode whenever possible, with the interrogation rate being progressively increased as the torpedo nears the target to improve system accuracy. The onboard computer performs several functions during the attack, including interrogation control, sonar data computation, torpedo steering control and data transmission to the submarine to update its computer memory. The onboard computer is connected through the guidance wire to the submarine's torpedo fire-control computer. During the wire guidance phase the torpedo's computer responds to the demands of the submarine computer, with wire being dispensed from both torpedo and submarine to avoid any stress due to their relative motion. Wire guidance ceases at the point where the torpedo's automatic three-dimensional passive/active acoustic homing system can control the final run to the target and during this phase the torpedo computer interprets data from the homing system sensors to calculate and then command the appropriate course, subject to a priority overriding steer-off azimuth control from the submarine.

Specifications
Length: 6.46 m (21.19 ft)
Diameter: 533 mm (21 in)
Weight: 1,550 kg (3,417 lb) (in air)
Propulsion: Electrically driven contrarotating propellers
Speed: 24 kts (passive), 35 kts (active)
Range: 7.5-22 n miles (13-39 km) (estimated)
Max operating depth: 610 m (2,000 ft) (estimated)
Warhead: Royal Ordnance 134 kg (295 lb) PBXN 105 warhead
Fuze: Dual-action impact (inertia-type) and proximity (magnetic)
Power: 2 Chloride silver-zinc oxide batteries driving a 2-speed electric motor
Propellers: 2, contrarotating

Manufacturer/Contractor
GEC-Marconi Underwater Weapons Systems Ltd, Waterlooville, Hampshire, UK.



Brazilian submarine, Humaita *(S 20), as originally delivered. The after end of the upper casing houses two torpedo tubes, which are retained in use only by the Brazilian Navy* (Brazilian Navy)

Alliant Mk 37 Mod 2

The Mk 37 Mod 2 is a wire-guided, export version of the 483 mm (19 in) weapon which is launched from the 'Humaita' class stern 533 mm (21 in) torpedo tubes, using guides.

Specifications
Length: 3.52 m (11.54 ft)
Diameter: 483 mm (19 in)
Weight: 645 kg (Mod 0/3 warshots)
Warhead: 150 kg HBX-3 (HE)
Speed: 24 kts (Mod 3)
Range: 4.4 n miles (8 km)
Max operating depth: 270 m (Mod 3)

Manufacturer/Contractor
Alliant Techsystems, Marine Systems, Hopkins, Minnesota, USA

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES (ECM)

Thorn-EMI UA 4

UA 4 is a radar warning set, giving visual and audible warning of radar transmissions, with a pulse analyser added later.

COMMAND AND CONTROL SYSTEMS

RADAR

Specifications
Type 1006 navigation radar
Role: Navigation
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 30 dB
Pulsewidth: 0.08/0.25/0.75 µs
Pulse repetition frequency: 725-1,000/1,450-2,000 pps
Scan rate: 26 rpm

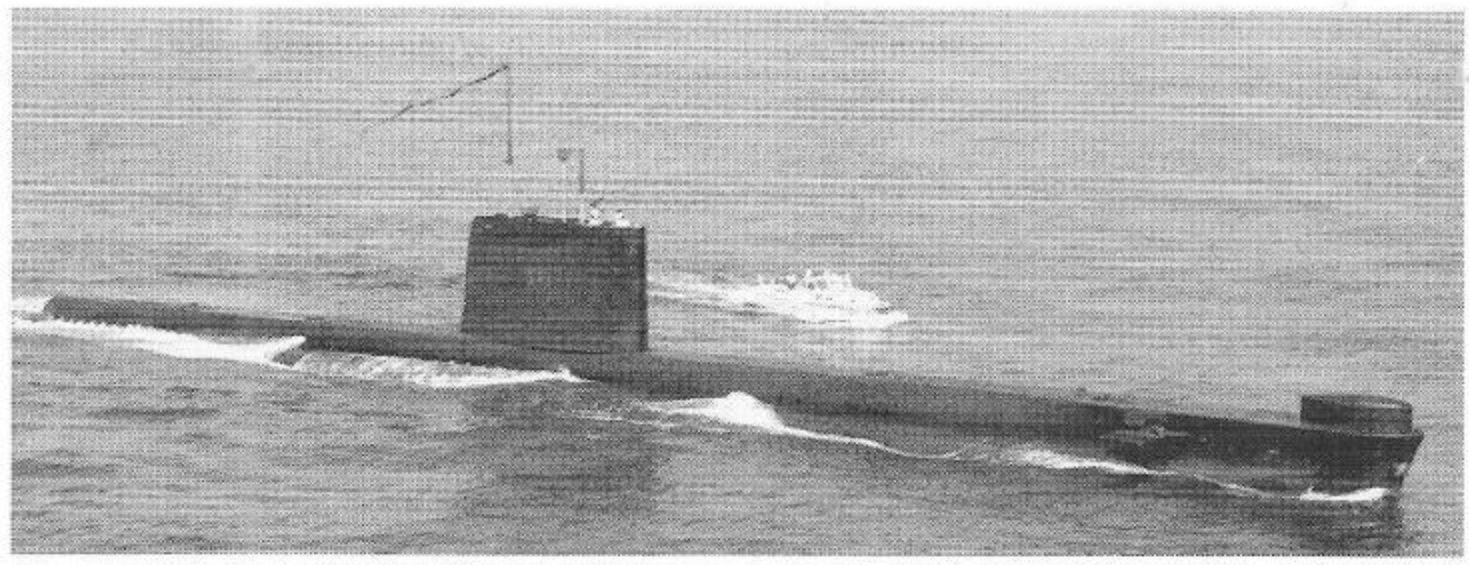
Manufacturer/Contractor
Kelvin Hughes, Ilford, Essex, UK.

SONARS

Atlas CSU-90-61

CSU-90-61 comprises three main sonars: a low-frequency flank array for long-range detection; an intercept passive sonar; and an attack panoramic passive sonar. The latter has a 2.8 m (9.19 ft) cylindrical hydrophone array and full azimuth coverage and a Demon processing capability. A target detected by any one of the three sonars initiates an automatic process of data collection. CSU 90 is equipped to handle eight independent compound tracks, each providing the warfare system with a complete set of tactical data. The total set of compound tracks comprises: (a) eight automatic target tracking (ATT) channels for the attack sonar; (b) eight ATT channels for the Demon path, each with eight ALTs (automatic line trackers); and (c) the Target Motion Analyser (TMA), which controls eight compound tracks and generates a sonar tactical display. Optional extensions include a passive ranging sonar, an own noise analyser, acoustic passive classification, automatic warning channel, target motion analyser, a disk memory unit, plotting devices and simulation facilities. The disk memory unit allows all displays and sonar data to be recorded for subsequent analysis and for training. It also handles the data for comparison purposes of the sonar information processor and the classification file for the intercept sonar.

Manufacturer/Contractor
STN Atlas Elektronik, Bremen, Germany.



Tonelero *(S 21). The flared bows, unique to the 'Oberon' class, ensure a good performance on the surface* (Brazilian Navy)

Graseby Marine Type 2007

Type 2007 is a low-frequency system which entered service in 1971; it uses steerable beams to detect and track hostile submarines. The search beams listen at frequencies between 1 and approximately 3 kHz to detect sounds caused by propeller cavitation, nuclear cooling pumps or turbine reduction gears. The array consists of 24 hydrophones evenly spaced along both sides of the hull.

Manufacturer/Contractor
Graseby Marine (Graseby Dynamics Ltd), Watford, UK.

PERISCOPES

Search: CK 24.
Attack: CH 74.

Manufacturer/Contractor
Pilkington Optronics, St Asaph, Clwyd, UK.

PROPULSION

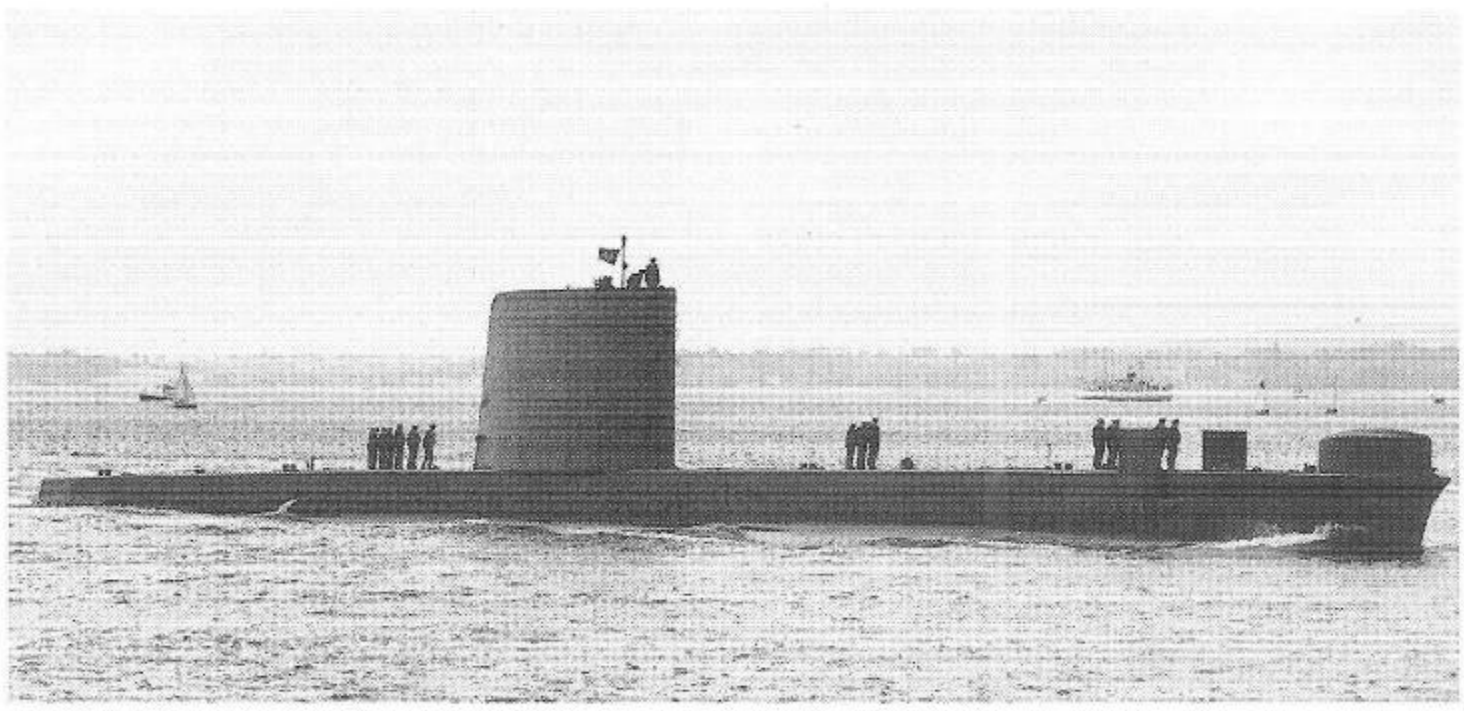
Specifications
System: Diesel-electric
Main machinery: 2 Admiralty Standard Range (ASR) 16 VVS-ASR1 diesels; 2.74 MW (3,680 hp)

Electric motors: 2 AEI motors; 4.48 MW (6,000 hp)
Shafts: 2
Battery: 2 groups, each of 224 cells; 5,000 Ah at 1 h rate, 7,420 Ah at 5 h rate

FURTHER INFORMATION

PROGRAMME

The first two boats were ordered from Vickers in 1969 and the third in 1972. There was a serious fire aboard *Toneleros* which started in the cabling while it was being fitted out, which resulted in it being towed to the Naval Dockyard at Chatham, where the entire centre section was replaced and the boat was completely rewired. As a result of this fire all Oberons under construction were rewired, with consequent delays, but there has been no recurrence of the problem.



Riachuelo *(S 22)* (H & L Van Ginderen Collection)

MODERNISATION

There were plans in the mid-1980s for a major modernisation programme, which would have included fitting the British Ferranti COMKAFS (Outfit DCH) fire-control system. This programme was, however, cancelled in 1990.

OPERATIONAL

Alone among the users of the 'Oberon' class, the Brazilian Navy retains the use of the two short torpedo tubes aft.

THE FUTURE

These three submarines are at the end of their useful lives and at one stage it was proposed to replace them with a class of Brazilian-designed and -built nuclear-powered attack submarines. Difficulties and delays have caused this programme to be postponed and it is now intended to replace them with a design known as the 'Improved Tupi', which will be designed and constructed in Brazil, but with diesel-electric power.

OBERON, CANADA

GENERAL SPECIFICATIONS

Operator: Canada
Type: Oberon

Class: OJIBWA

Bought: 3
In service: 3 (plus two hulks — see 'Further Information')

Displacement:
surfaced: 2,030 t
submerged: 2,410 t

Dimensions
Length: 90 m (295.2 ft)
Beam: 8.1 m (26.5 ft)
Draught: 5.5 m (18 ft)

Speed:
surfaced: 12 kts
snorting: 10 kts
submerged: 17 kts
Diving depth: 200 m (656 ft)

Range, surfaced: 9,000 n miles at 12 kts

Complement: 65 (7 officers)

SUBMARINES

OJIBWA (72)
Builder Naval Dockyard, Chatham, UK
Laid down 27 Sep 1962
Launched 29 Feb 1964
Commissioned 23 Sep 1965

ONONDAGA (73)
Builder Naval Dockyard, Chatham, UK
Laid down 18 Jun 1964
Launched 25 Sep 1965
Commissioned 22 Jun 1967

OKANAGAN (74)
Builder Naval Dockyard, Chatham, UK
Laid down 25 Mar 1965
Launched 17 Sep 1966
Commissioned 22 Jun 1968

WEAPONS SYSTEMS

TUBES

There are six 533 mm (21 in) bow tubes.
Total weapon load, 20.

TORPEDOES

Mk 48 Mod 4

The Mk 48 torpedo is an anti-submarine and anti-ship weapon, capable of operating in wire-guided, acoustic and non-acoustic modes, with the acoustic modes being either active or passive. Externally the Mk 48 is a long slim cylinder with a flat nose and four fins faired into the afterbody ahead of the shrouded, axial-flow, pump-jet propulsor. The wire link is two-way, enabling data from the weapon's homing and guidance system to be relayed to the submarine fire-control system, so that the weapon can be guided more accurately from the submarine.

Specifications
Length: 5.84 m (19.16 ft)
Diameter: 533 mm (21 in)
Weight: 633 kg (1,395 lb)
Range: 21 n miles (38 km) at 55 kts or 27 n miles (50 km) at 40 kts
Max depth: 760 m (2,490 ft)
Max speed: 55 kts
Warhead: 267 kg (589 lb)

Manufacturers/Contractors
Hughes Aircraft Company, Ground Systems Group (prime).
Westinghouse Electric Corporation second source).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Radar warning.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Singer-Librascope SFCS Mk 1 Mod 0

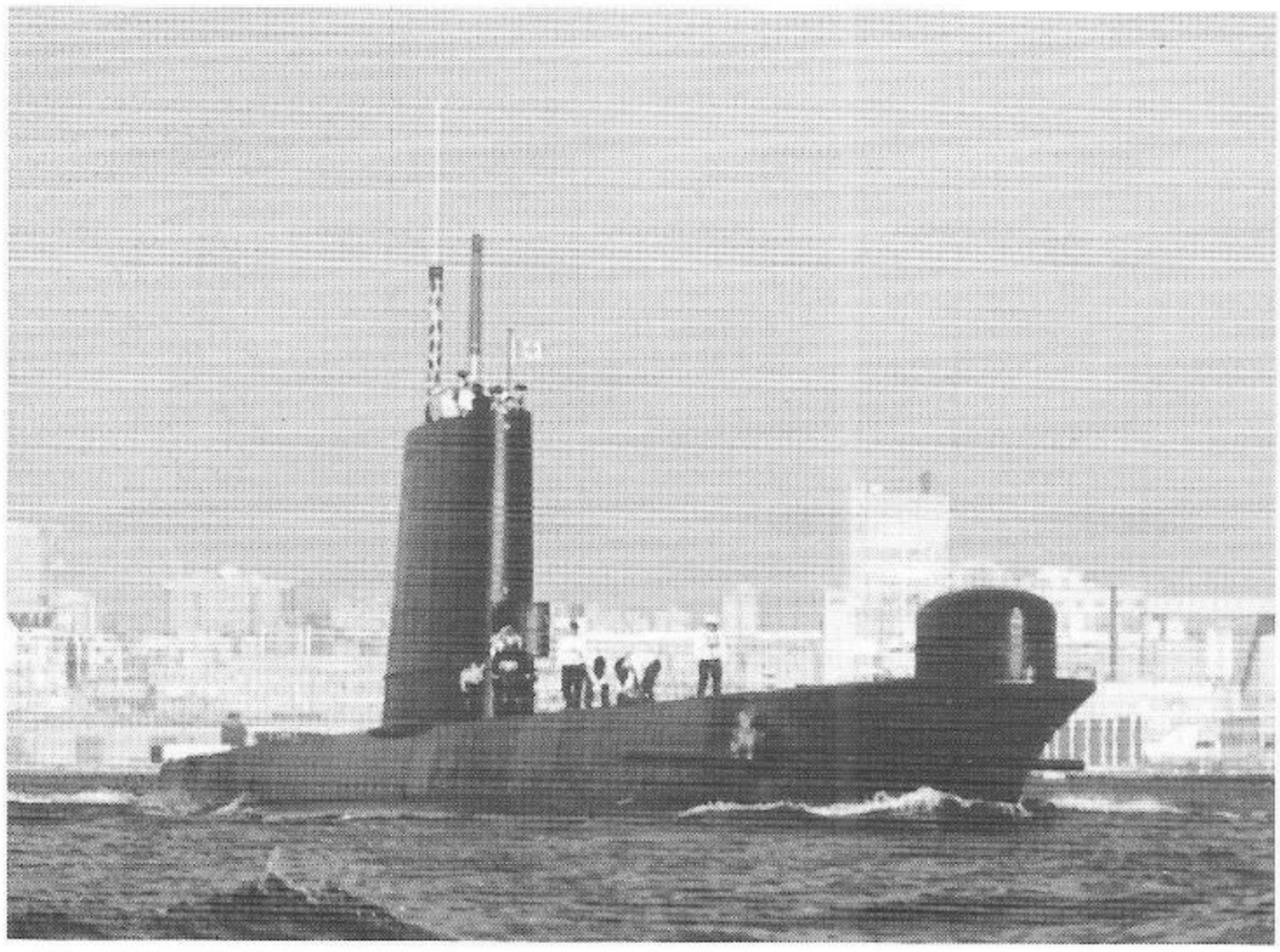
Submarine Fire-Control System Mk 1 (SFCS Mk 1) was produced in the late 1970s by Singer-Librascope and installed in the Australian 'Oberon' class submarines, and later purchased by Canada to update its Oberons. It is a mainframe architecture system based upon the 16-bit AN/UYK-20 mini-computer, which has a 64 k memory and can store up to 30 minutes of data from a sonar channel or a sonar assignment unit. It is complemented by a Librascope CL 107MA 409 k 16-bit memory mass memory unit with a 409 k memory which is used to store track data as well as for other digital data. The electronics circuit cards are US Navy Standard Electronic Modules and programming uses CMS-2 language software. SFCS Mk 1 can detect up to 20 targets, can track four and can engage two. TMA is conducted upon any four of the nine sonar channels with measurements every second then being averaged over 20 second intervals. The Canadians use the SFCS Mk 1 Mod 0, which does not have the facility to interface with Sub-Harpoon missiles.

Manufacturers/Contractors
Loral-Librascope, Glendale, California, USA (prime).
Rockwell Systems Australia, North Ryde, NSW, Australia (Australian version).

RADAR

Specifications
Type 1006 navigation radar
Role: Navigation
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 30 dB
Pulsewidth: 0.08/0.25/0.75 µs
Pulse repetition frequency: 725-1,000/1,450-2,000 pps
Scan rate: 26 rpm

Manufacturer/Contractor
Kelvin Hughes, Ilford, Essex, UK.



Ojibwa, *with its original angular sonar dome. Note also that in this view the forward hydroplanes are extended* (Canadian Armed Forces)

SONARS

Plessey Triton Type 2051

This sonar system was produced for the update programme of the British Navy's 'Oberon' class submarines. It was known as Type 2051 in UK service, while the export version was designated 'Triton', the prime contractor being GEC-Marconi Naval Systems with Ferranti-Thomson Sonar Systems as co-contractor. The main elements of the system are: a compact narrowband sonar linked to the submarine's existing flank array; a clip-on towed array to provide all-round surveillance and classification; broadband passive sonars for both bow and flank arrays; an active sonar with variable power and sector capabilities; and an intercept sonar. A newly designed and rather elegant bow sonar dome was produced to improve the hydrodynamic performance of the submarine and reduce water flow noise. The three sets in the Canadian boats were diverted from the production order for British boats.

Manufacturers/Contractors
GEC-Marconi Naval Systems, Sonar Systems Division, Templecombe, Somerset, UK (prime).
Ferranti-Thomson Sonar Systems UK Ltd, Stockport, UK (co-contractor).

Graseby Marine Type 2007

The flank array in the Canadian boats is the Type 2007 low-frequency system, which entered service in 1971; it uses steerable beams to detect and track hostile submarines. The search beams listen at frequencies between 1 and approximately 3 kHz to detect sounds caused by propeller cavitation, nuclear cooling pumps or turbine reduction gears. The array consists of 24 hydrophones evenly spaced along both sides of the hull.

Manufacturer/Contractor
Graseby Marine (Graseby Dynamics Ltd), Watford, UK.

Sperry MicroPUFFS

The passive ranging system is the Sperry MicroPUFFS which was originally developed for the Australian Navy by Sperry in the mid-1970s, but was later procured by the Canadians. As its name suggests, it was derived from the US Navy PUFFS (Passive Underwater Fire-control Feasibility Study) hardware. There are three baffled arrays of hydrophones mounted on each side of the submarine, connected to a display control console, which utilises an analogue processor, digital processor and AN/UYK-26 computer.

MicroPUFFS provides automatic target tracking of up to four simultaneous targets, instantaneous and continuous ranging solution, fire-control range and bearing output, and secure operation. The two arrays each form five beams covering a 150° sector and the basic technique is signal enhancement by cross correlation of the signals received at the arrays with conversion of two measured time differentials into bearing and range data.

Manufacturer/Contractor

Unisys Corporation, Defense Systems, Great Neck, New York.

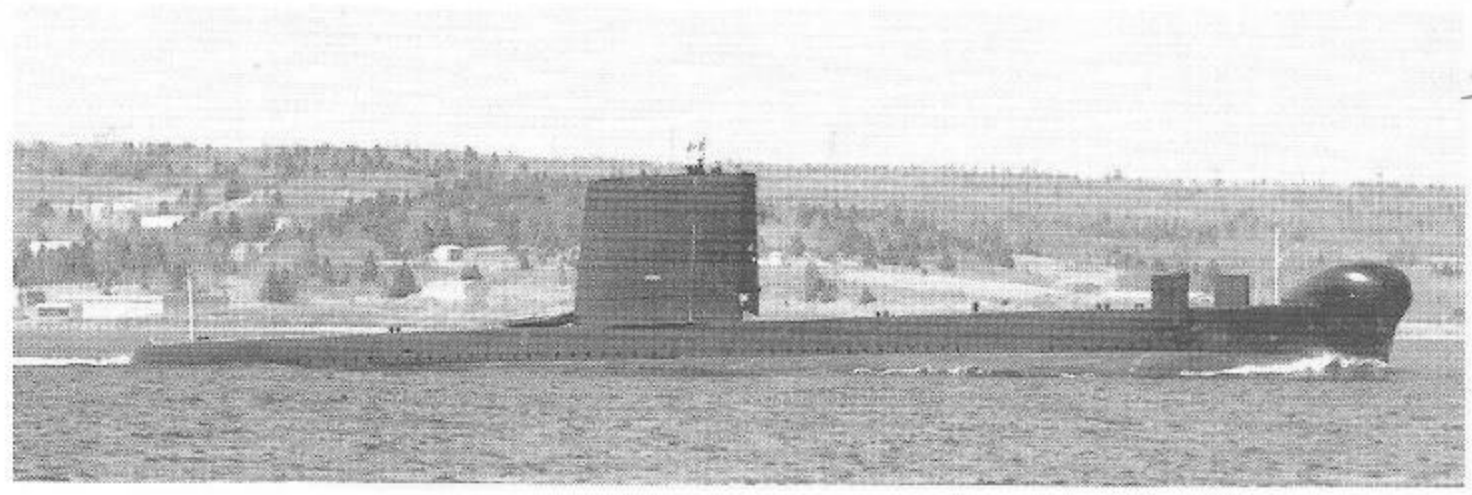
GEC-Marconi SUBTASS

SUBTASS (Submarine Towed Array Sonar System) is the clip-on towed array component of the Triton system. It is based on GEC-Marconi's modular Hydra technology and commonality with Type 2051 leads to reduced spares holdings and training requirements and increased operator familiarity and interchangeability. Hydra's modular flexibility allows use of the Canadian-designed and produced array modules from Hermes Electronics Ltd, as well as future enhancements and expansion.

Manufacturers/Contractors

GEC-Marconi Naval Systems, Sonar Systems Division, Templecombe, Somerset, UK (prime).

Hermes Electronics, Dartmouth, Nova Scotia, Canada (array modules).



Ojibwa, *with the current streamlined bow dome, which houses a Plessey Triton Type 2051 sonar array. It was originally intended to replace these three boats with up to 12 nuclear-powered submarines, but that plan fell through and the Canadian plans for a replacement for these ageing boats are not yet finalised* (Canadian Armed Forces)

PERISCOPES

Search: CK 24.
Attack: CH 74.

Manufacturer/Contractor

Pilkington Optronics, St Asaph, Clwyd, UK.

PROPULSION

Specifications

System: Diesel-electric
Main machinery: 2 Admiralty Standard Range (ASR) 16 VVS-ASR1 diesels; 2.74 MW (3,680 hp)
Electric motors: 2 AEI; 4.48 MW (6,000 hp)
Shafts: 2
Battery: 2 groups, each of 224 cells; 5,000 Ah at 1 h rate, 7,420 Ah at 5 h rate

FURTHER INFORMATION

PROGRAMME

In 1962 the Ministry of National Defence announced that Canada was to buy three 'Oberon' class submarines from the UK. The first of these was obtained from the Royal Navy construction programme. Having been laid down as *Onyx* for the British Navy it was launched as the Canadian *Ojibwa.* The other two were built to meet the Canadian order from the start. Some design changes were incorporated to meet specific national requirements, including Canadian communications equipment and an increase in air conditioning capacity to meet the wide extremes of climate encountered in Canadian operating areas.

Two former British Navy 'Oberon' class submarines have been purchased, but are not operational. Ex-*Olympus* was purchased in July 1989 and is used as an alongside trainer at Halifax; it is incapable of putting to sea. The second, ex-*Osiris*, was purchased in 1992 and is used solely as a source of spares for the three operational boats.

MODERNISATION

Having entered service in 1965-68, all three underwent a major modernisation programme known as the Submarine Operational Update Project (SOUP) in the early 1980s: *Ojibwa* 1980-82; *Onondaga* 1982-84; and *Okanagan* 1984-86. This included general refurbishment as well as the installation of more modern sonar and fire-control equipment.

Further work was undertaken in 1987 when weapon launching and fire-control systems were upgraded to take the US Mk 48 torpedo. Plessey Triton Type 2051 sonar was installed in 1989 and they were later fitted to take the GEC-Marconi/Hermes SUBTASS towed array, starting with *Okanagan* in 1993, with the torpedo fire-control system (TFCS) being updated at the same time. The two stern tubes have been blanked off.

All three operational boats are to undergo one further refit to add a few more years to their already long lives.

THE FUTURE

The question of replacements for these three submarines has been under discussion for a considerable time. In the late 1980s there was a project to purchase no less than twelve nuclear-propelled attack submarines (SSN) but this over-ambitious plan was eventually cancelled. This was followed in the mid-1990s by a proposal to buy the four redundant British 'Upholder' class diesel-electric submarines, which had strong support from the Navy, but was eventually rejected on financial grounds by the Canadian Government.

As a temporary solution, all three boats are to undergo one further refit to add just a few more years to their already long operational service:

Submarine	Refit	Strike
***Ojibwa* (SS 72)**	1993-95	2000
***Onandaga* (SS 73)**	1996-98	2002
***Okanagan* (SS 74)**	1998-2000	2004

This will give the Canadian Forces and government a few more years breathing space in which to decide what to do, but it is extremely doubtful that any more years of service can be squeezed out of these elderly boats.

OBERON, CHILE

GENERAL SPECIFICATIONS

Operator: Chile
Type: Oberon

Class: O'BRIEN

Built: 2
In service: 2

Displacement:
surfaced: 2,030 t
submerged: 2,410 t

Dimensions
Length: 90 m (295.2 ft)
Beam: 8.1 m (26.5 ft)
Draught: 5.5 m (18.1 ft)

Speed:
surfaced: 12 kts
snorting: 10 kts
submerged: 17 kts

Complement: 65 (7 officers)

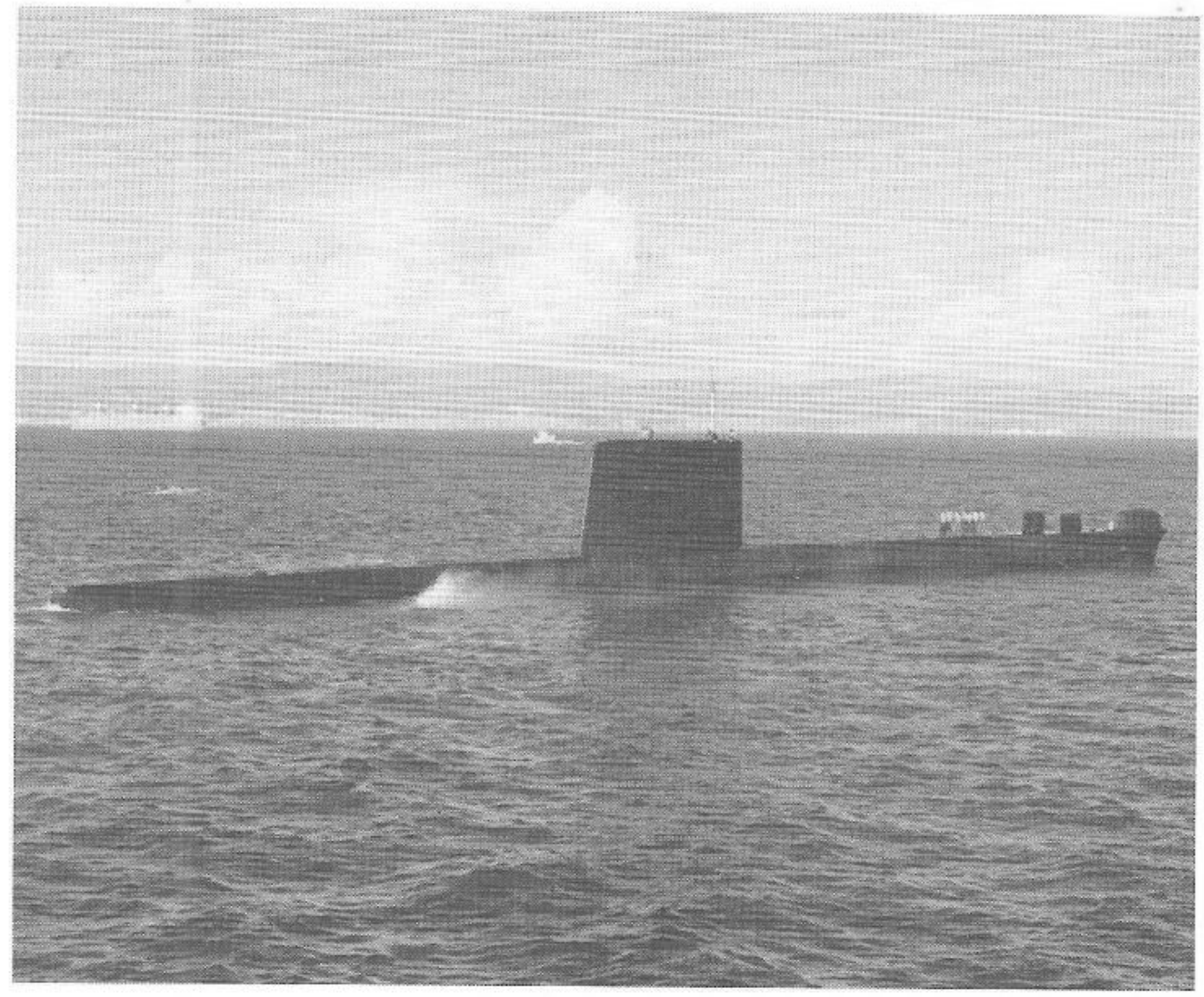
SUBMARINES

O'BRIEN (22)

Builder	Scott-Lithgow, Greenock, UK
Laid down	17 Jan 1971
Launched	21 Dec 1972
Commissioned	15 Apr 1976

HYATT (23)

Builder	Scott-Lithgow, Greenock, UK
Laid down	10 Jan 1972
Launched	26 Sep 1973
Commissioned	27 Sep 1976



Hyatt *(23), one of two 'Oberon' class submarines built for the Chilean Navy in the early 1970s. They have been regularly modernised but are now in need of replacement. The Chilean Navy's plans have not yet been announced, but are believed to involve either the four surplus British Upholders or new-build Type 209s, although other options cannot be ruled out at this stage*

WEAPONS SYSTEMS

TUBES

There are eight 533 mm (21 in) tubes; six full-length bow tubes, two short stern tubes (see Further Information (below)).
Total weapon load, 22.

TORPEDOES

STN ATLAS SUT

SUT (Surface and Underwater Target) is a dual-purpose, wire-guided torpedo for use against both surface and submarine targets. It is electrically propelled and the wire guidance gives immunity to interference with a two-way datalink between vessel and torpedo. The acoustic homing head has long acquisition ranges and a wide search sector for active and passive operation. The large payload with combined fuze systems ensures the optimum effect of explosive power. The SUT operates at great depths as well as in very shallow waters. Consort operation permits exploitation of the full over-the-horizon range of the SUT.

Specifications
Length: 6.15 m (20.18 ft)
Diameter: 533 mm (21 in)
Weight: 1,420 kg (3,130 lb)
Warhead: 260 kg (573 lb)
Speed: Selectable, max 35 kts
Range: 6.5 n miles (12 km) at 35 kts; 15 n miles (28 km) at 23 kts
Fuze: Magnetic, proximity and impact

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen/Hamburg, Germany.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Racal Porpoise ESM system

Porpoise is the submarine version of Racal's Cutlass fully automatic ESM system, with a 360° azimuth. The equipment receives signals in the 2 to 18 GHz frequency range, measures their parameters and compares these with those contained in a radar threat library; up to 2,000 radar modes are held in the library and the operator can add data on up to 100 more emitters. Intercepted signals are preamplified in the mast unit before being passed to the processing and analysis equipment where bearing data are extracted using amplitude comparison. Amplitude, pulsewidth, frequency and time are combined in a single digital word before being passed to the processor unit in the operator's console, where pulse trains of the different radars are de-interleaved and identified from the library information. The system is integrated with the vessel's fire-control and communications systems and with periscope-mounted radar warning equipments. Porpoise can also give an alert warning when prime threats, such as helicopter or maritime surveillance radars, reach a programmed danger level. The Porpoise antenna is a compact six-port system made of titanium, which gives good bearing accuracy and may be mounted on either hull penetrating or non-hull penetrating masts.

Manufacturer/Contractor
Racal Radar Defence Systems Ltd, Chessington, UK.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

SISDEF Torpedo Guidance System (TGS)

These two submarines were fitted in 1992 with an STN Atlas fire-control system modified by the Chilean naval hardware/software house, SISDEF, in conjunction with STN Atlas. Designated the Torpedo Guidance System (TGS) it is designed to acquire, process, analyse and display data from all sensors fitted in the boat and, in particular for the CSU-90 sonar suite. The system integrates the acoustic arrays, as well as 'own noise' hydrophones and accelerometers, Doppler and EM log; underwater telephone; radar; ESM; optic and optronic sensors and navigation sensors. It can handle all types of torpedo in service with the Chilean Navy.

Manufacturers/Contractors
STN Atlas Elektronik GmbH, Bremen, Germany.
SISDEF, Vina del Mar, Chile.

RADAR

Specifications
Type 1006 navigation radar
Role: Navigation
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 30 dB
Pulsewidth: 0.08/0.25/0.75 µs
Pulse repetition frequency: 725-1,000/1,450-2,000 pps
Scan rate: 26 rpm

Manufacturer/Contractor
Kelvin Hughes, Ilford, Essex, UK.

SONARS

Atlas CSU-90-61

CSU-90-61 comprises three main sonars: a low-frequency flank array for long-range detection; an

intercept passive sonar; and an attack panoramic passive sonar. The latter has a 2.8 m (9.19 ft) cylindrical hydrophone array and full azimuth coverage and a Demon processing capability. A target detected by any one of the three sonars initiates an automatic process of data collection. CSU 90 is equipped to handle eight independent compound tracks, each providing the warfare system with a complete set of tactical data. The total set of compound tracks comprises: (a) eight automatic target tracking (ATT) channels for the attack sonar; (b) eight ATT channels for the Demon path, each with eight ALTs (automatic line trackers); and (c) the Target Motion Analyser (TMA), which controls eight compound tracks and generates a sonar tactical display. Optional extensions include a passive ranging sonar, an own noise analyser, acoustic passive classification, automatic warning channel, target motion analyser, a disk memory unit, plotting devices and simulation facilities. The disk memory unit allows all displays and sonar data to be recorded for subsequent analysis and for training. It also handles the data for comparison purposes of the sonar information processor and the classification file for the intercept sonar.

Manufacturer/Contractor

STN Atlas Elektronik, Bremen, Germany.

PERISCOPES

Search: CK 24.
Attack: CH 74.

Manufacturer/Contractor

Pilkington Optronics, St Asaph, Clwyd, UK.

PROPULSION

Specifications

System: Diesel-electric
Main machinery: 2 Admiralty Standard Range (ASR) 16 VVS-ASR1 diesels; 2.74 MW (3,680 hp)
Electric motors: 2 English-Electric; 4.48 MW (6,000 hp)
Shafts: 2
Battery: 2 groups, each of 224 cells; 5,000 Ah at 1 h rate, 7,420 Ah at 5 h rate

FURTHER INFORMATION

PROGRAMME

These two submarines were ordered from Scott's Shipbuilding & Engineering Co Ltd, Greenock, in late 1969. Both suffered delays in fitting out due to re-cabling as a result of the fire in the Brazilian *Tonelero,* followed by a minor explosion in *Hyatt* in January 1976.

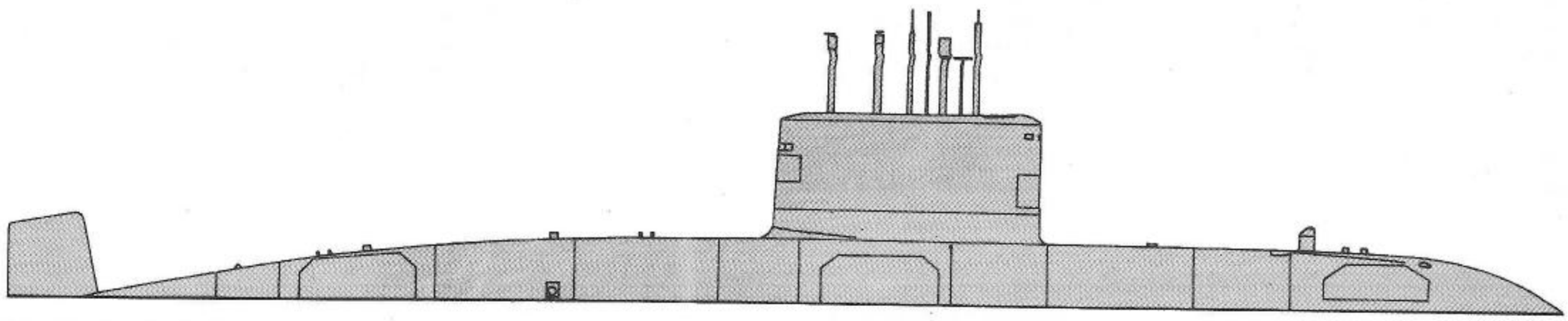
MODERNISATION

The STN Atlas fire-control system was fitted in 1992 and the same company's CSU 90 sonar suite is currently being installed to replace the Type 187.

OPERATIONAL

These two boats collided with each other while running on the surface in April 1987; the damage was limited and was repaired at the Asmar yard at Talcahuano, Chile. The after tubes are no longer used.

UPHOLDER



Upholder (Ian Sturton)

GENERAL SPECIFICATIONS

Country: United Kingdom

Class: UPHOLDER
Type: 2400

Built: 4
Active: 0
Awaiting sale: 4

Displacement:
surfaced: 2,168 t
submerged: 2,455 t

Dimensions
Length: 70.3 m (230.6 ft)
Beam: 7.6 m (25.0 ft)
Draught: 5.5 m (17.7 ft)

Speed:
surfaced: 12 kts
snorting: 12 kts
submerged: 20 kts
Range:
snorting: 8,000 n miles at 8 kts
submerged: 90 hours at 3 kts

Endurance: 49 days stores
Diving depth: Greater than 200 m (650 ft)

Complement: 47 (7 officers)

SUBMARINES

UPHOLDER (S 40)

Builder	Vickers Shipbuilding & Engineering Ltd (VSEL), Barrow-in-Furness, Cumbria, UK
Start date	Nov 1983
Launched	2 Dec 1986
Commissioned	9 Jun 1990
Decommissioned	Apr 1994

UNSEEN (S 41)

Builder	Cammell Laird, Birkenhead, UK
Start date	Jan 1986
Launched	14 Nov 1989
Commissioned	7 Jun 1991
Decommissioned	Apr 1994

URSULA (S 42)

Builder	Cammell Laird, Birkenhead, UK
Start date	Aug 1987
Launched	28 Feb 1991
Commissioned	8 May 1992
Decommissioned	Jun 1994

UNICORN (S 43)

Builder	Cammell Laird, Birkenhead, UK
Start date	Feb 1989
Launched	16 Apr 1992
Commissioned	25 Jun 1993
Decommissioned	1995

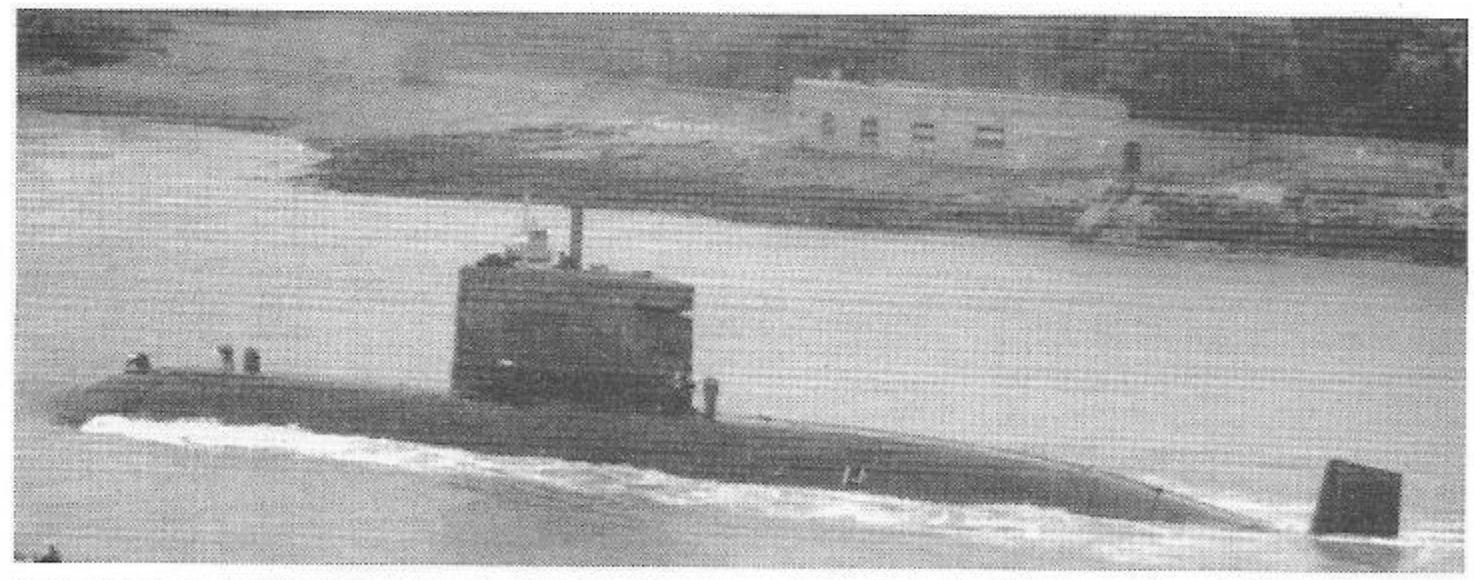
WEAPONS SYSTEMS

ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Sub-Harpoon Block 1C

All British SSNs and SSBNs carry Sub-Harpoon anti-ship missiles as part of their weapon load, which are either Block 1B or Block 1C versions. Block 1C has a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
Block 1C
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s



'Upholder' class. These boats were designed for a combat role in the GIUK gap (Jane's/HM Steele)

Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuse: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TUBES

Six 533 mm (21 in) bow tubes; air-turbine pump discharge.
Total weapon load: 18 missiles/torpedoes.

TORPEDOES

GEC-Marconi Mk 24 Tigerfish

Tigerfish uses the passive mode whenever possible, with the interrogation rate being progressively increased as the torpedo nears the target to improve system accuracy. The onboard computer performs several functions during the attack, including interrogation control, sonar data computation, torpedo steering control and data transmission to the submarine to update its computer memory. The onboard computer is connected through the guidance wire to the submarine's torpedo fire-control computer. During the wire-guidance phase the torpedo's computer responds to the demands of the submarine computer, with wire being dispensed from both torpedo and submarine to avoid any stress due to their relative motion. Wire guidance ceases at the point where the torpedo's automatic

three-dimensional passive/active acoustic homing system can control the final run to the target and during this phase the torpedo computer interprets data from the homing system sensors to calculate and then command the appropriate course, subject to a priority overriding steer-off azimuth control from the submarine. If the Upholders had remained in British service they would also have carried Spearfish.

Specifications
Length: 6.46 m (21.19 ft)
Diameter: 533 mm (21 in)
Weight: 1,550 kg (3,417 lb) (in air)
Propulsion: Electrically driven contrarotating propellers
Speed: 24 kts (passive), 35 kts (active)
Range: 7.5-22 n miles (13-39 km) (estimated)
Max operating depth: 610 m (2,000 ft) (estimated)
Warhead: Royal Ordnance 134 kg (295 lb) PBXN 105 warhead
Fuze: Dual-action impact (inertia-type) and proximity (magnetic)
Power: 2 Chloride silver-zinc oxide batteries driving a 2-speed electric motor
Propellers: 2, contrarotating

Manufacturer/Contractor
GEC-Marconi Underwater Weapons Systems Ltd, Waterlooville, Hampshire, UK.

MINES

Stonefish mines can be carried in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

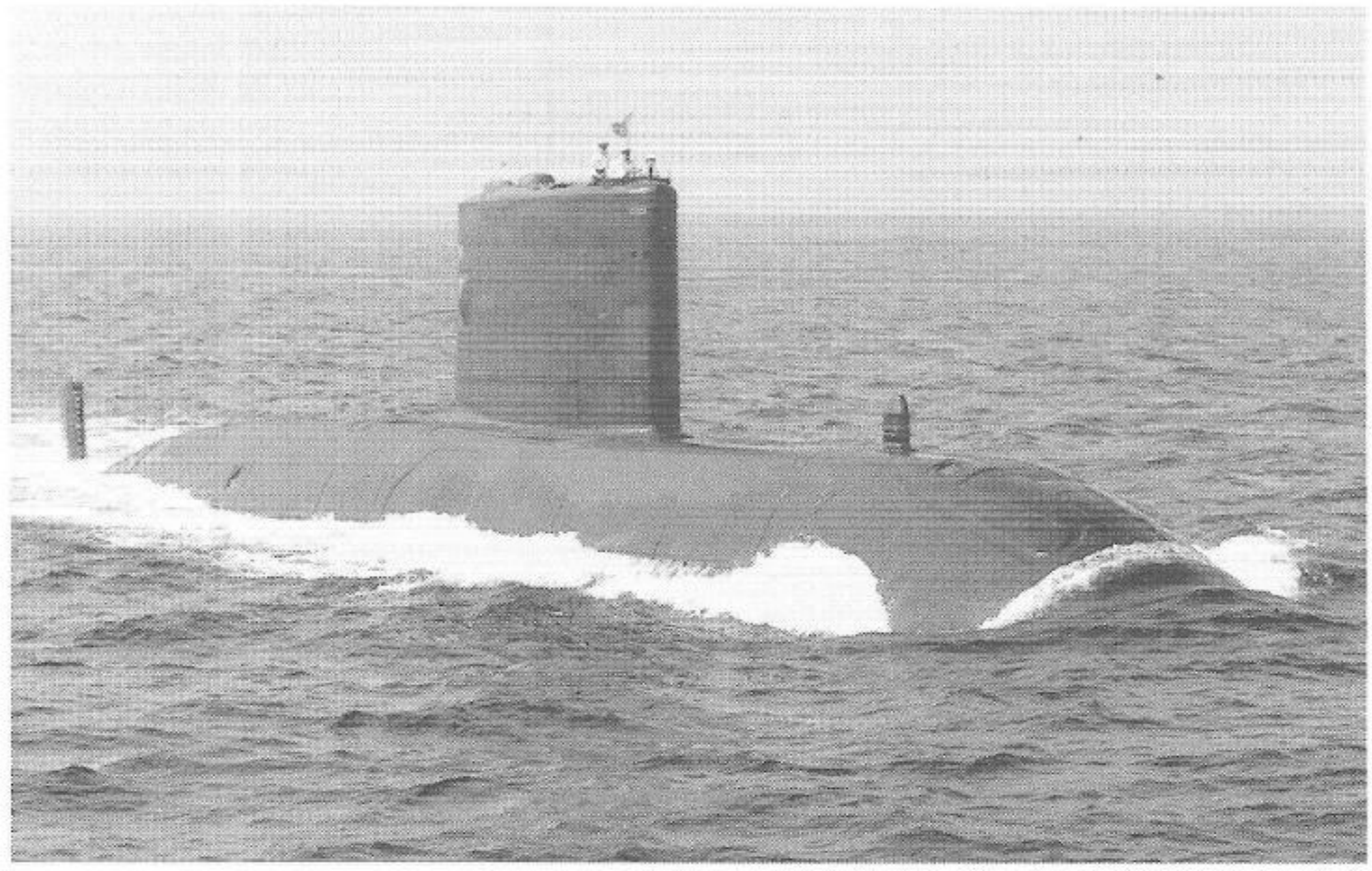
Racal Type UAC
The ESM passive intercept set in the Upholders is the Type UAC which would have been updated to Type UAP (formerly known as Type UAC (1)) had the submarines remained in British service.

Manufacturer/Contractor
Racal Radar Defence Systems, Chessington, UK.

ELECTRONIC COUNTERMEASURES (ECM)

Strachan & Henshaw SSDE Mk 6
Two SSDE (Submarine Signal and Decoy Ejectors) Mk 6. There are two SSDEs, one forward, the other aft, which are used to eject decoys (for example, Type 2066 and Type 2071) and communications buoys, such as the ECB-680(1) and ECB-699 communications buoys (see below).

Manufacturer/Contractor
Strachan & Henshaw, Bristol, UK.



Upholder *on builder's trials. These four boats were among the most capable and sophisticated diesel-electric submarines ever built* (VSEL)

Dowty Type 2066
The Type 2066 is a torpedo decoy launched from the SSE.

Manufacturer/Contractor
Dowty, Ross-on-Wye, UK.

Gearing & Watson Type 2071 torpedo decoy
The Sonar Type 2071 (also known as UW300S) is a depth-compensated, low-frequency acoustic projector which transmits complex signals consisting of tones, noise bands or pulses to provide noise countermeasures against sonars and torpedo homing heads. The device consists of a user-programmable digital signal generator (DSG), a power amplifier, hydrosounder with pressure compensator and a test unit.

The DSG is capable of simultaneously generating up to 11 different signals, which may comprise single tones, swept tones, bands of random noise, modulated noise, or pulses. The type, frequency, amplitude and duration of these signals is programmed into the DSG using a keypad and displayed for the operator via a VDU. The DSG is able to store in memory up to eight sets of programs, thus eliminating the need to reprogramme each time the system is used. Prerecorded data may also be routed through the DSG.

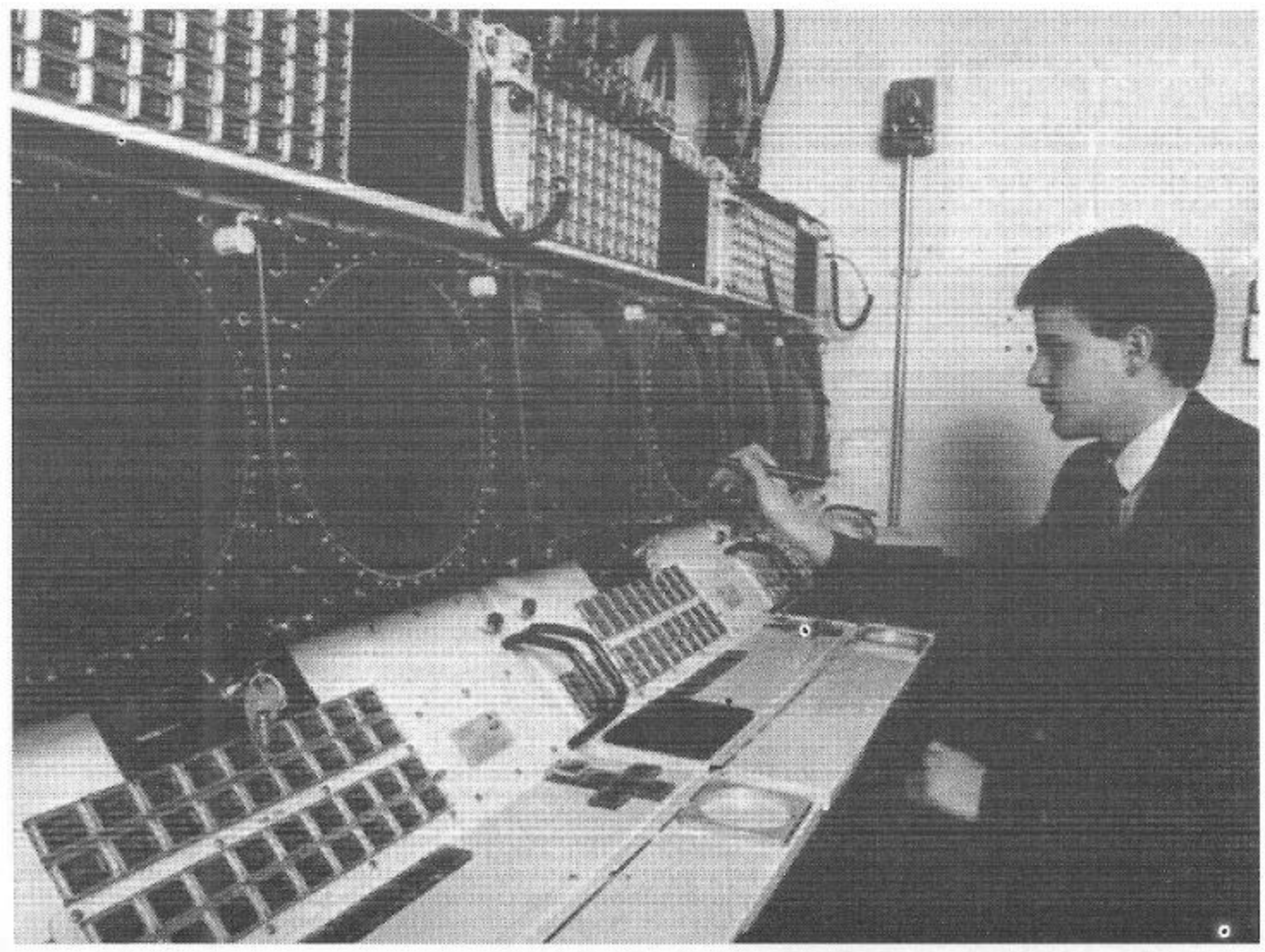
Manufacturer/Contractor
Gearing & Watson (Electronics) Limited, Hailsham. Eastbourne, UK.

COMMAND AND CONTROL SYSTEMS

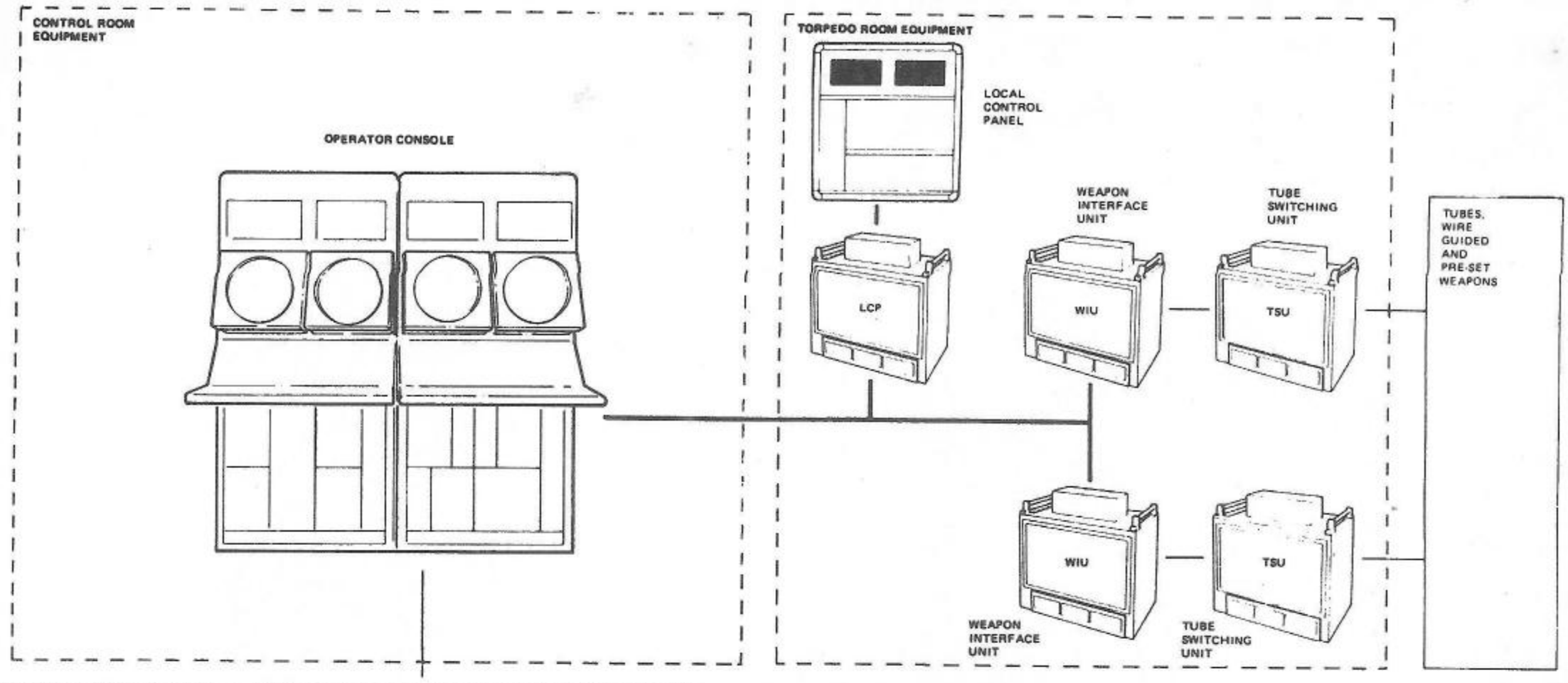
COMBAT DATA SYSTEMS

Ferranti-Gresham-Lion System DCC tactical data handling system
The System DCC tactical data handling and fire-control system was developed from the System DCB used in British SSNs and was intended specifically for the 'Upholder' class SSKs. Data are passed to System DCC via the digital databus from the various sensors, which include long-range passive sonar, medium-range passive/active sonar, sonar intercept, passive ranging sonar (three arrays on each side of the hull), underwater communications, bathythermograph, and sound speed-measuring system. A variety of electronic and electro-optical devices are carried on the periscope masts while the Kelvin Hughes Type 1006/7 surface surveillance and navigation radar, and omnidirectional/directional ESM are carried on a separate mast.

System DCC comprises a three-position console in the submarine's control room and there are two FM 1600E system computers to ensure back-up should the main computer fail. The sensor data are collated, processed and presented in plan, time/bearing or time/



DCC panel undergoing test prior to installation (Ferranti)



Outline of KAFS system, which is the export version of DCC (Ferranti)

frequency form on the console displays, with supplementary or amplifying data being shown on the tote displays. Contact data are also output to the Automatic Contact Evaluation Plotter (ACEP). The processing, which includes target motion analysis (TMA) and tactical calculations, is provided to support the command in the assessment of the tactical situation and the decision making processes.

Upholder weapons include dual-purpose (anti-ship/anti-submarine) wire-guided torpedoes, Sub-Harpoon and mines. Fire-control facilities for these weapons are integrated into System DCC and include target designation, weapon and tube preparation, weapon launch and, where appropriate, post-launch guidance. Weapon settings, tube orders and weapon orders are passed to the weapon interface equipments which apply power and switch signals to the tubes and weapons during the preparation and launch phases. After firing, the data feedback from the wire-guided torpedoes is passed to the central computer which generates steer commands as required, and also updates the fire-control information on the displays.

Manfacturers/Contractors
GEC-Marconi, Portsmouth, UK.
Ultra Electronics, Feltham, Middlesex, UK.

RADAR

Kelvin Hughes Type 1007 I band.

Specifications
Role: Navigation
Frequency: I-band
Beam: 1.0 × 18°
Peak power: 25 kW
Antenna gain: 31 dB
Pulsewidth: 0.08/0.35/0.8 µs
Pulse repetition frequency: 1,600/800/400 pps
Scan rate: 26 rpm

Manufacturer/Contractor
Kelvin Hughes, Ilford, Essex, UK.

SONARS

Thomson-Marconi Type 2040
Hull-mounted; passive search and intercept; medium frequency.

Manufactuer/Contractor
Thomson-Marconi Sonar Ltd, Stanmore, Middlesex, UK.

Graseby Marine Type 2007
Type 2007 is a long-range passive flank array sonar, with three aligned arrays on either side of the submarine. It uses steerable beams and operates in the 1 to 3 kHz frequency range. It is used for initial detection at long range as well as for discovering bearings.

Manufacturer/Contractor
Graseby Marine, Watford, UK.

Thomson-Marconi Type 2026
The Type 2026 is the passive towed array sonar in *Upholder* (S 40) only. It is capable of detecting both broad and narrowband noise and includes sensitive hydrophones, a new broadband processor in the low-frequency band and a Curtis architecture processor.

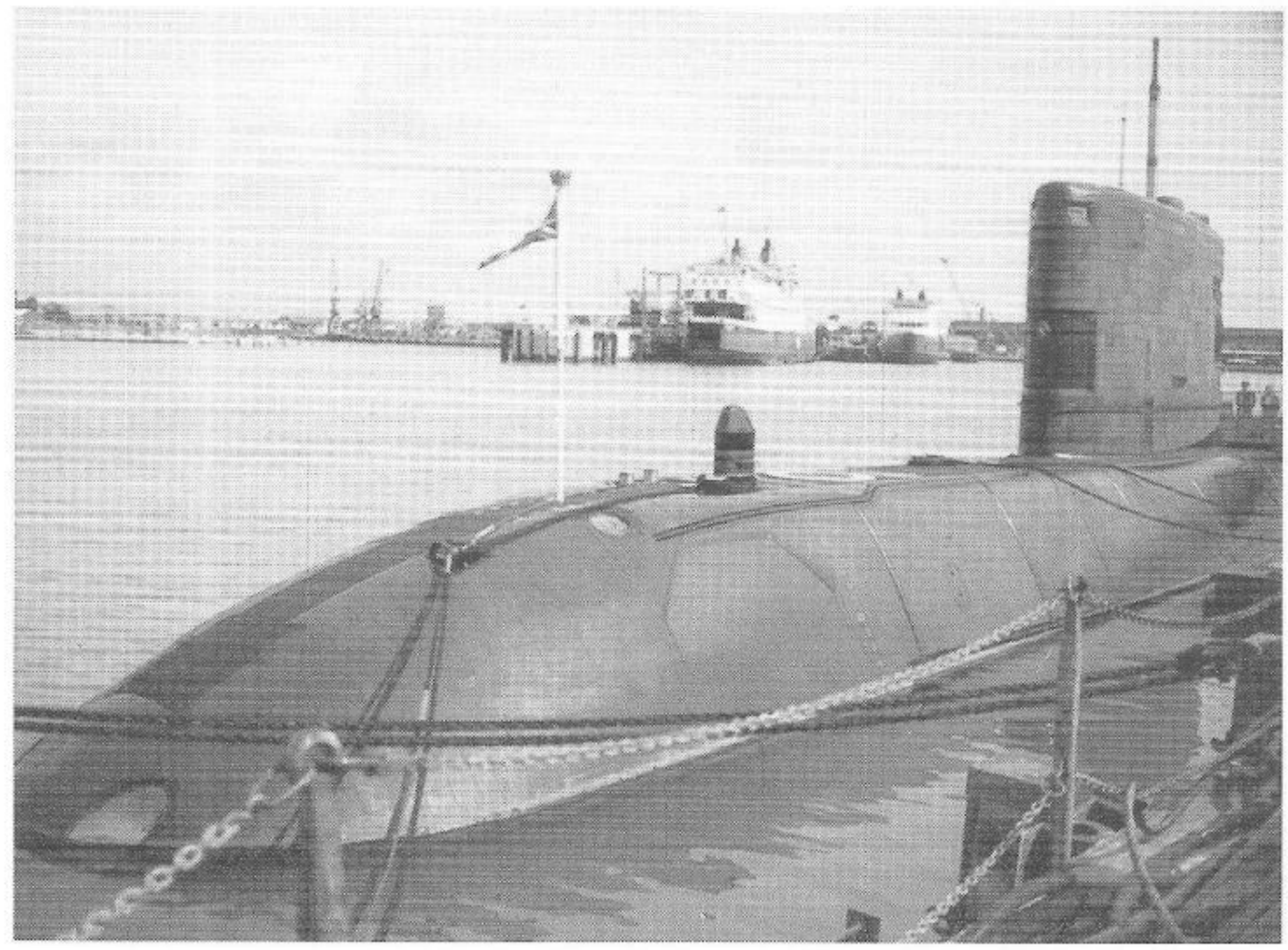
Manufacturer/Contractor
Thomson-Marconi Sonar Ltd, Stanmore, Middlesex, UK.

Thomson-Marconi Type 2046
Type 2046 is the towed array in the three submarines other than *Upholder* (S 40). Type 2046 is a 50 m (164 ft) long, passive search array, operating at very low frequencies. It is used for long-range target detection, classification and tracking.

Manufacturer/Contractor
Thomson-Marconi Sonar Ltd, Stanmore, Middlesex, UK.

Unisys Type 2041
This is a passive ranging sonar designed specifically for the 'Upholder' class.

Manufacturer/Contractor
Unisys, McLean, Virginia, USA.



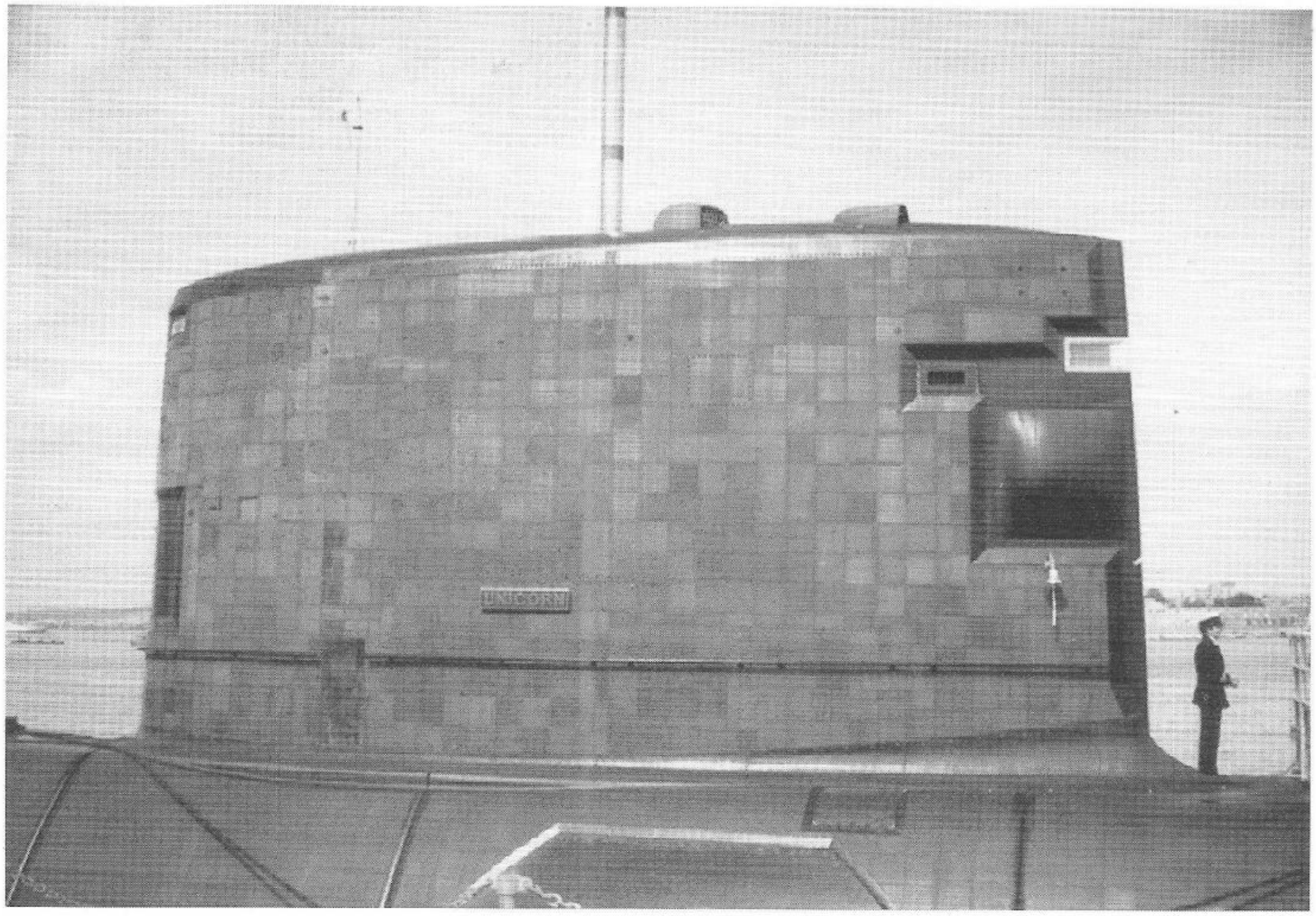
Unicorn. *The large trapezoidal shape in the side is one of three arrays for the Type 2007 sonar*

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 Paxman Valenta 16SZ diesels; 2.7 MW (3,620 hp) sustained

Alternators: 2 GEC alternators; 2.8 MW
Electric motor: 1 GEC motor; 4 MW (5,400 hp)
Shaft: 1
Propeller: 7-bladed, skew-back

Battery: 2 groups, each of 240 cells; 6,080 Ah 1 hour rate, 8,800 Ah at 5 hour rate



Unicorn *showing the complete coating of anechoic tiles* (Jane's/David Miller)

FURTHER INFORMATION

PROGRAMME

The last of the 13 British 'Oberon' class diesel-electric submarines was commissioned in 1967 and there followed a long debate on whether any further conventional submarines would ever be required by the British Navy. Eventually, however, it was decided that there was, indeed, a requirement. The Type 2400, which had already been designed by VSEL as a commercial venture, was selected for production as the the 'Upholder' class, the order for the first of class being placed on 2 November 1983, followed by an order for a further three on 2 January 1986. There was even talk of an eventual class total of 12, but plans for more of the class were dropped in 1990 as part of a cost-cutting exercise which was designed to reduce the diesel submarine strength to four boats by the mid-1990s.

The first of class was built by VSEL at its Barrow-in-Furness yard, but the company purchased the Cammell-Laird yard in Birkenhead to produce the rest of the class. When production ended with the completion of the fourth hull, Cammell-Laird closed.

DESIGN

The 'Upholder' class is among the most sophisticated and capable diesel-electric submarines ever built. The tear-drop hull is exceptionally short and fat with a beam: length ratio of 1:9, giving three deck levels inside. The pressure hull has a single skin constructed of NQ-1 high-tensile steel and is covered in elastomeric acoustic tiles.

There is a five-man lockout chamber in the fin. This is the first time that the Valenta diesel has been fitted in submarines.

Curiously, this class was not fitted with the British-developed pump-jet propulsor, having, instead, a more conventional seven-bladed, skew-back propeller.

OPERATIONAL

On entry into service it was discovered that there were severe problems with the torpedo discharge system. This required dockyard work on *Upholder* (1992), *Unseen* and *Ursula* (both in 1993), while *Unicorn's* tubes were rectified before commissioning.

During their brief period of service all four were based at Devonport as part of the Second Submarine Squadron. According to a ministerial statement announcing their withdrawal from service, these boats were designed to operate in general war in the northern part of the Greenland-Iceland-United Kingdom (GIUK) gap against Soviet SSBNs and SSNs deploying into the North Atlantic.

SALES

After a defence review in 1994 it was announced that the end of the Cold War meant that there was no further operational requirement for any British diesel-electric submarines and all four were withdrawn from service and offered for sale. They have been returned to Barrow-in-Furness where they are being maintained by VSEL, pending a sale.

The four Upholders have been offered for sale to Canada, which country urgently needs replacements for its ageing 'Oberon' class boats, but despite considerable enthusiasm in navy circles the Canadian Cabinet turned the sale down. The UK is now seeking alternatives and possible purchasers are believed to be South Africa and Chile. Taiwan is believed to have made an offer, but such a sale would meet with intense opposition from the PRC.

When they are eventually sold these submarines will require a substantial refit as they have been out of service for some time. Some equipment may have to be removed on security grounds, while other equipment may already have been removed for use in other British submarines and need replacement. Nevertheless, they will represent an excellent bargain as their usage has been minimal.

GUPPY/TANG

OVERVIEW

Although now very old, twelve post-war US diesel-electric submarines remain in service with a number of navies, and despite their decreasing numbers, they remain significant. Most of them are Guppy types, although several Tangs also remain, and it is necessary to describe the background to the various modification programmes in order to appreciate the difference between them

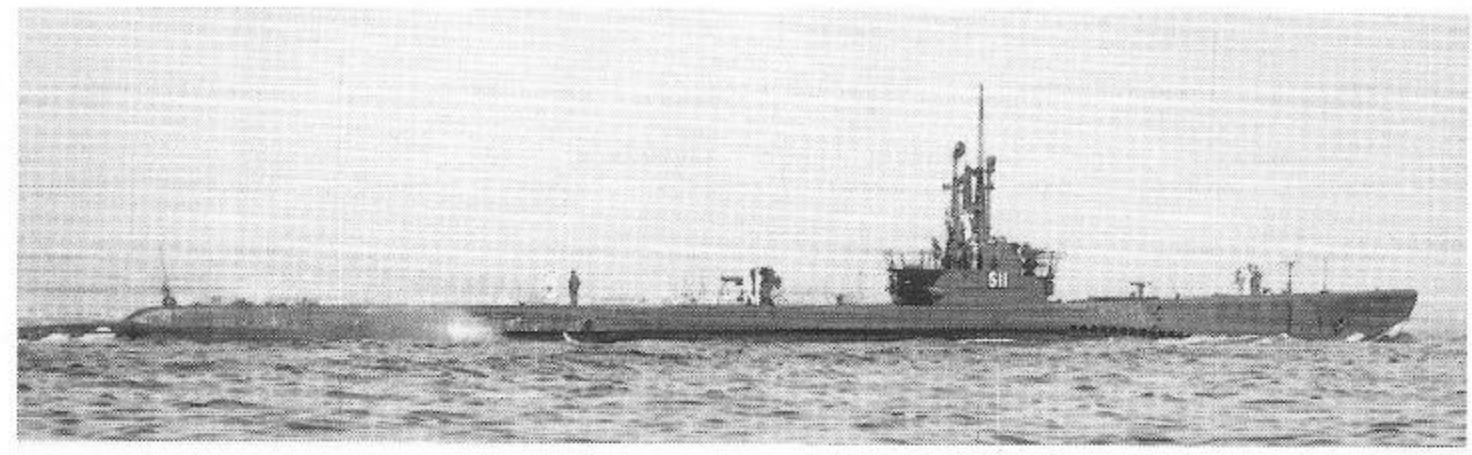
At the end of the Second World War the US Navy found itself with vast numbers of 'Gato', 'Balao' and 'Tench' class fleet submarines, all of which had been outdated at a stroke by the German Type XXI. This revolutionary design was the world's first true submarine, whose normal environment was underwater, whereas every one of its predecessors had been a submersible, capable of limited operations underwater and then only when forced to do so.

Although officially divided into three classes, these US boats were, in fact, very similar. The 'Gato' class came first, followed by the 'Balao' class, which had thicker skins and were constructed of high-tensile rather than mild steel, which increased their diving depth from 90 m (300 ft) to 122 m (400 ft). The 'Tench' class was simply a refinement of the design, with rearranged fuel and ballast tanks and a new type of slow-speed, direct-drive main motors.

After the war there were numerous programmes to either improve these submarines for their basic role or to convert them for other tasks, such as radar pickets, hunter-killers, amphibious transports and missile launchers. The longest lasting boats, however, have been those which underwent the most significant improvements, which was designated the Greater Underwater Propulsion Program (GUPPY). In general, this programme included streamlining the hull and superstructure, removing unnecessary protuberances, increasing battery power and fitting a schnorkel; measures which combined to produce more range, much increased underwater speeds and greater tactical effectiveness.

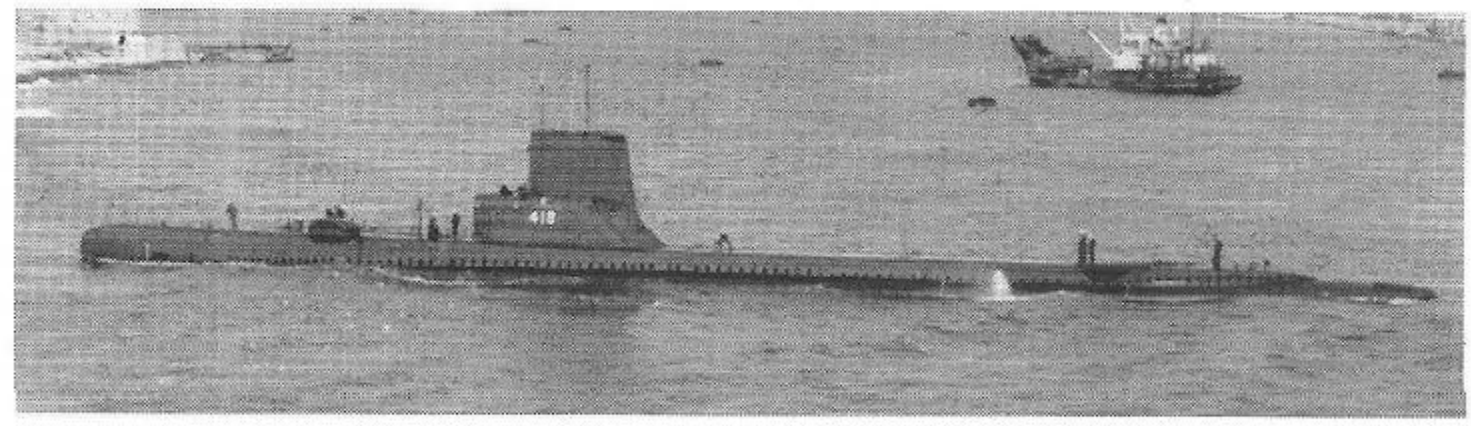
The start point for the various Guppy conversions was that the original US fleet submarine was an excellent design and had specifically included a margin for future developments. There were three major variations within the Guppy programme, and a number of minor ones, as the designers struggled to fit all these new developments into the basic hull, in their efforts to produce a submarine that was both tactically effective and financially affordable.

Guppy I. The first conversion was carried out on two boats in 1945-47 and was aimed at producing high-speed targets for US ASW forces to train against, although, in the event, they actually turned out to be the prototypes for the Guppy programme. They were given



The start point of the Guppy programme was the large number of 'Gato/Balao/Tench' class boats which survived the Second World War. The picture shows Argentine submarine Santa Fé *(S 11) in 1960, but with no change from its original form as US 'Balao' class* Macabi *(SS 375). The bridge, masts, railings and 101 mm (4 in) gun all combined to reduce underwater speed to 8 knots* (H & L van Ginderen Collection)

One of the numerous post-war conversions was the radar pickets, which were intended to act as forward controls for cruise missiles. This is Tigrone *(SSR 419) in 1955* (H & L van Ginderen Collection)



Thornback *(SS 418) as a Guppy IIA, which were generally similar to the Guppy II, but with one engine removed and fewer batteries to create more space* (H & L van Ginderen Collection)

POST-WAR US DIESEL-ELECTRIC PATROL SUBMARINES

Type	Number produced/ converted	Year completed	Displacement	Length	Torpedo tubes (total weapons)	Speed Surfaced	Speed Submerged	Remarks
Gato	77	1941-43	2,424 t	95.02 m	10 (24)	20.25 kts	8.75 kts	These also had one or two 3 in, 4 in or 5 in deck guns
Balao	119	1942-45	2,415 t	95.02 m	10 (24)	20.25 kts	8.75 kts	
Tench	25	1943-46	2,415 t	95.0 m	10 (28)	20.25 kts	8.75 kts	
GUPPY I	2	1947	2,400 t	93.73 m	10 (24)	17.8 kts	18.2 kts	
GUPPY IA	10	1951	2,440 t	93.75 m	10 (24)	18 kts	15 kts	
GUPPY IB	4	1953-55	2,440 t	93.6 m	10 (24)	17 kts	5 kts	
GUPPY II	24	1948-50	2,420 t	93.57 m	10 (24)	18.0 kts	16.0 kts	
GUPPY IIA	16	1952	2,445 t	93.57 m	10 (24)	18.0 kts	15.0 kts	
GUPPY III	9	1962	2,870 t	98.15 m	10 (28)	17 kts	14 kts	
Tang	6	1951-52	2,260 t	82.0 m	8 (21)	15.5 kts	18.3 kts	

extra batteries and a streamlined sail and hull, which enabled them to achieve just over 18 knots submerged. Two were converted in this Guppy I programme and both were later reconverted to Guppy II.

Guppy II. Learning from the Guppy I programme, 24 were converted to Guppy II over the period 1948 to 1951. This involved 17 serving Balao and Tench boats, five unfinished hulls on which work had been suspended at the end of the war, and the two Guppy Is. The work involved additional batteries, streamlining sail, schnorkel and considerable internal reorganisation.

Guppy IA. Chronologically following the Guppy II programme, the Guppy IA involved ten more 'Balao' and 'Tench' class boats, which were converted in 1951-52. This involved similar treatment to Guppy II, but with less drastic internal rearrangement. One of these boats, USS *Chopper* (SS 342) gave an excellent demonstration of the inherent strength of the design on 11 February 1969 when it suddenly went out of control and descended very rapidly to a depth of about 300 m (1,000 ft) before being brought under control and nursed back to the surface, an incident in which it exceeded its design maximum of 126 m (412 ft) by a very considerable margin.

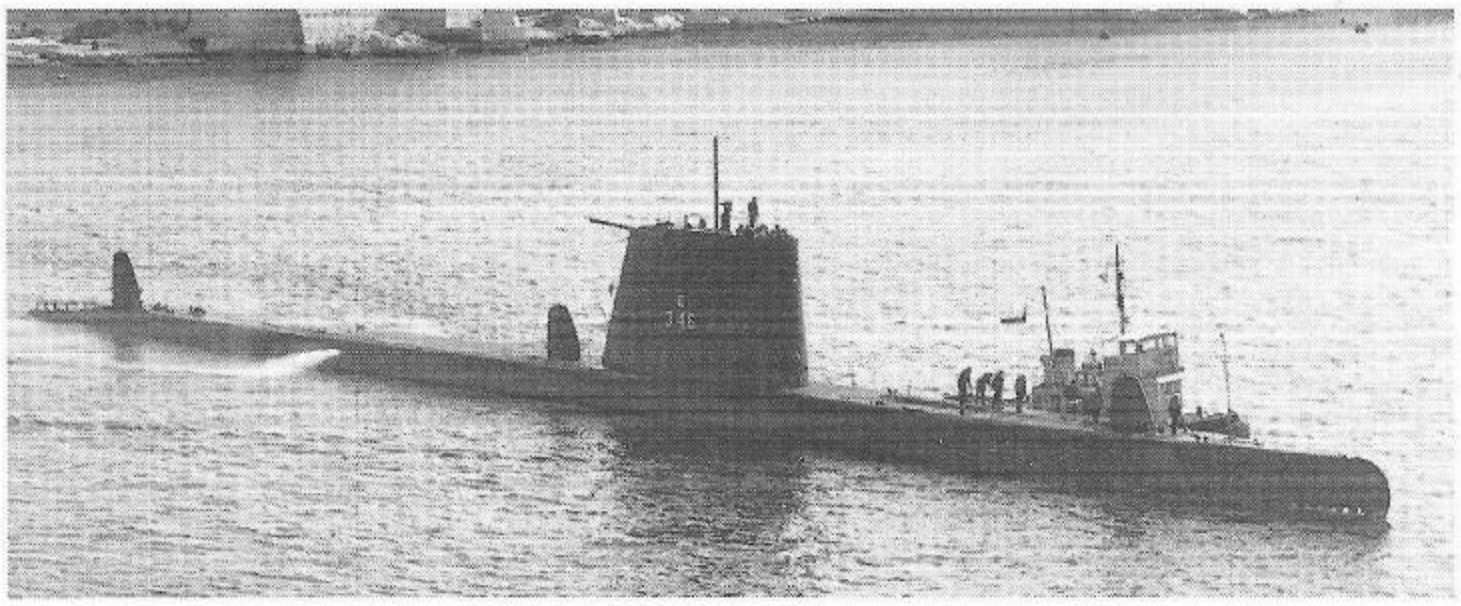
Guppy IIA. This involved a further 16 Balao and Tench conversions to a generally similar standard to the Guppy II, but with less drastic internal reorganisation. The Guppy IIs were, however, notoriously crowded and in order to improve habitability one engine and one generator were removed, which slightly reduced the performance although the gains in space and maintainability were reckoned to offset this.

Guppy IB. These were four boats sold abroad, two to the Netherlands and two to Italy, which were given an 'austere' version of the Guppy IA conversion prior to delivery.

Guppy III. This was the final and most drastic Guppy conversion and was undertaken to extend the lives of a small number of boats in order to maintain the size of the US submarine fleet until sufficient numbers of nuclear-powered attack submarines were in service. It involved nine Guppy IIs, which were converted to Guppy III standard between 1959 and 1962. The most drastic element of the conversion was that the hulls were cut in two and a 4.57 m (15 ft) plug inserted to create extra space so that the number of torpedo reloads could be increased and to improve accommodation for the crew. In addition, the conning tower was lengthened and all equipment was either modernised or totally refurbished. Externally, the two most characteristic features of these boats were the three fins on the upper casing, which accommodated the hydrophones of the PUFFS sonar system (the acronym stemming from the initial project, known as the Passive Underwater Fire-control Feasibility Study), and the very high, streamlined, GRP sail.

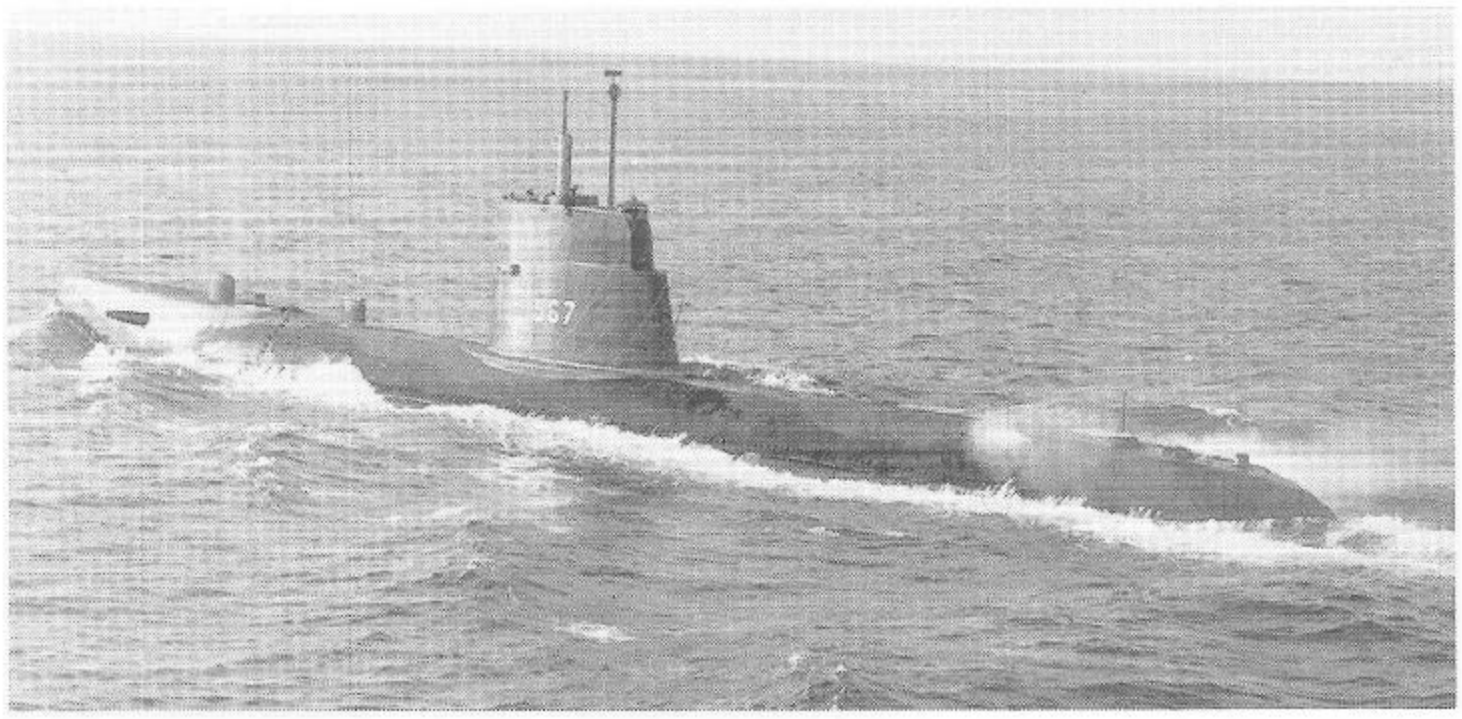
Once the SSNs started joining the fleet in significant numbers, these boats, already elderly even then, were retired from the US Navy, but large numbers were transferred to friendly navies. Of these, no less than nine survive in three navies and most of these will still be in service at the end of the century.

Tang. Although a new-build and not a Guppy conversion, it is convenient to deal with the 'Tang' class here. The 'Tang' class was the first class of new attack submarines to be built after the end of the Second World War, and thus the first to include all the lessons of the conflict, especially of the German Type XXIs. The first four were 82.0 m (269.02 ft) long and were powered by a new type of radial diesel, described as a 'pancake' design, which was intended to save space, but proved to be a complete failure. The last two boats were still being built, so their hulls were lengthened to 84.73 m (278.0 ft) and they were fitted with the conventional Fairbanks-Morse 38D8 diesels. The first four were then lengthened by the same amount to have the same type of engines fitted, but all six were later lengthened to 87.47 m (287 ft). They were generally superior to the Guppys, except that their torpedo tubes were reduced to six forward and two aft, and the total weapon load was reduced to 21 torpedoes.



Corporal *(SS 346) as a Guppy III in 1967. Note the large plastic sail and the three fins for the PUFFS sonar system. The hull was also lengthened by some 4.6 m (15 ft)* (H & L van Ginderen Collection)

Corporal *(SS 346) as a Guppy II. Note the streamlined hull and stepped sail. The glass dome over the bridge was necessary to protect the watch-keepers* (H & L van Ginderen Collection)



The six boats of the 'Tang' class were commissioned in 1951-52 and incorporated all the lessons of the Second World War and the post-war Guppy programmes. This is Gudgeon *(SS 567) in 1953* (H & L van Ginderen Collection)

GUPPY II

GENERAL SPECIFICATIONS

Country: Taiwan

Class: GUPPY II

Bought: 2
In service: 2

Displacement:
surfaced: 1,870 t
submerged: 2,420 t

Dimensions
Length: 93.7 m (307.5 ft)
Beam: 8.3 m (27.2 ft)
Draught: 5.5 m (18 ft)

Speed:
surfaced: 18 kts
submerged: 15 kts
Range, surfaced: 8,000 n miles at 12 kts
Complement: 75 (7 officers)

SUBMARINES

HAI SHIH (791)		**Converted to Guppy II**	1948	**Laid down**	23 Aug 1943
Builder	Navy Yard, Portsmouth, USA	**Decommissioned US Navy**	12 Apr 1973	**Launched**	8 Jul 1945
Laid down	22 Jul 1944	**Transferred**	12 Apr 1973	**Commissioned**	11 Apr 1946 (USS *Tusk* (SS 426)
Launched	5 Nov 1944			**Decommissioned US Navy**	18 Oct 1973
Commissioned	17 Mar 1945 (USS *Cutlass* (SS 478)	**HAI BAO** (792)		**Transferred**	18 Oct 1973
		Builder	Cramp Shipbuilding, Philadelphia, USA		

WEAPONS SYSTEMS

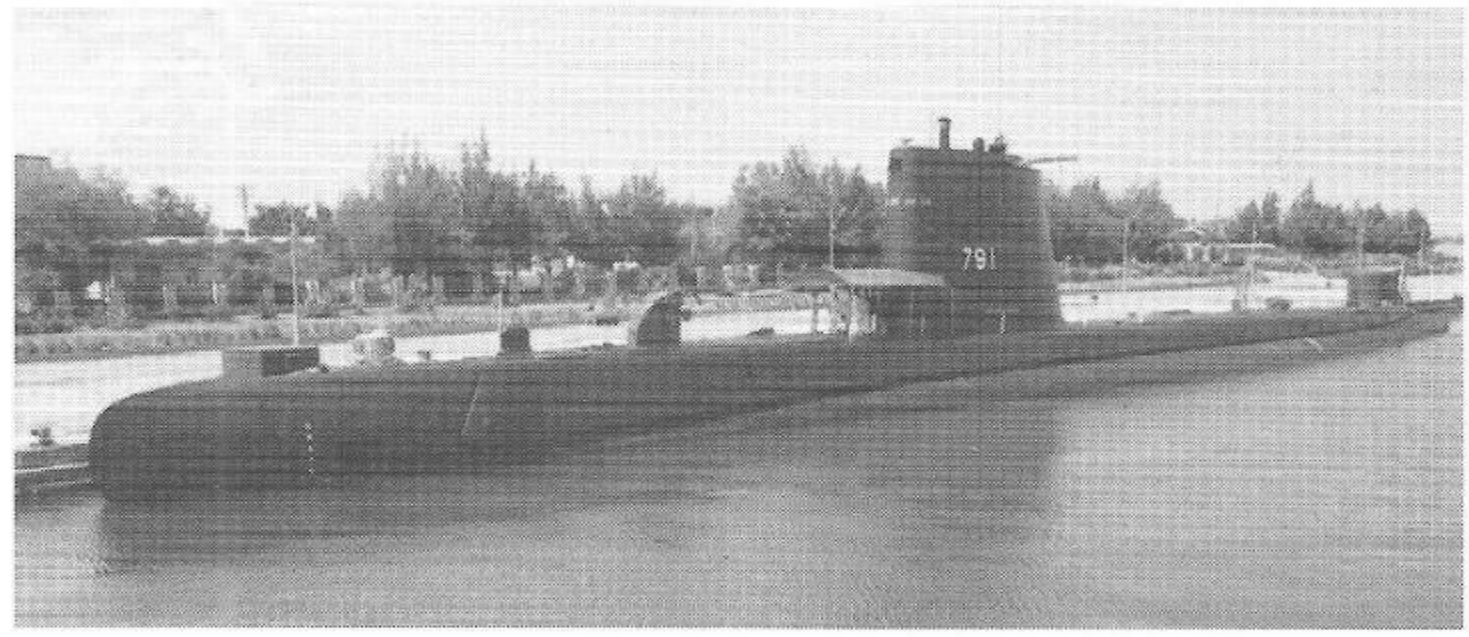
TUBES

10–533 mm (21 in) (six bows; four stern).
Total weapon load, 21.

TORPEDOES

STN Atlas SUT
SUT (Surface and Underwater Target) is a dual-purpose, wire-guided torpedo for use against both surface and submarine targets. It is electrically propelled and the wire guidance gives immunity to interference with a two-way datalink between vessel and torpedo. The acoustic homing head has long acquisition ranges and a wide search sector for active and passive operation. The large payload with combined fuze systems ensures the optimum effect of explosive power. The SUT operates at great depths as well as in very shallow waters. Consort operation permits exploitation of the full over-the-horizon range of the SUT. (See Further Information below)

Specifications
Length: 6.15 m (20.18 ft)
Diameter: 533 mm (21 in)



Hai Shih *(791) is one of two Guppy II boats serving in the RoC Navy. These were transferred in 1973 with their torpedo tube doors welded shut, but this was quickly rectified* (DTM)

Weight: 1,420 kg (3,130 lb)
Warhead: 260 kg (573 lb)
Speed: Selectable, max 35 kts
Range: 6.5 n miles (12 km) at 35 kts; 15 n miles (28 km) at 23 kts
Fuze: Magnetic, proximity and impact

Manufacturer/Contractor
STN Atlas Elektronik GmbH, Bremen/Hamburg, Germany.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

WLR-1
A 1960s vintage US Navy system, the WLR-1 is a wide bandwidth radar warning system, covering 50 MHz to 10.75 GHz.

WLR-3
WLR-3 is another elderly intercept system.

COMMAND AND CONTROL SYSTEMS

RADAR

SS-2
SS-2 was one of the earlier US Navy post-war submarine radars. It operates in the I-band and is very dated.

SONARS

EDO BQR-2B
The BQR-2B passive search and attack sonar was installed in most US Navy 'Guppy' class submarines. The hull-mounted, cylindrical array operates at medium frequency (0.5-15 kHz).

Raytheon/EDO BQS-4C
Also of early 1950s vintage, BQS-4C adds an active capability to the BQR-2B. The BQS-4C array consists of seven vertically stacked cylindrical transducers mounted inside the BQR-2C array, with the latter also acting as the BQS-4C's receiver. Operating frequency is 7 kHz.

Thomson Sintra DUUG-1B
DUUG-1B is a passive ranging sonar, which was originally installed in French 'Daphné' class submarines.

PROPULSION

Specifications

System: Diesel-electric
Main Machinery: 3 Fairbanks-Morse 38D1/8 diesels; 3.3 MW (4,500 hp)
Propulsion motors: 2 Elliott motors; 4 MW (5,400 hp)
Shafts: 2
Battery: 4 groups, each of 126 Guppy-type cells

FURTHER INFORMATION

PROGRAMME

These two submarines were originally both 'Tench' class units, which were extensively modernised under the Guppy II programme, which, after service in the US Navy were transferred to the Republic of China Navy in 1973 and were the first submarines to be operated by that service. The ostensible role for which they were to be used was to act as high-speed targets for ASW training and, to add credance to this, they had their torpedo tube doors welded shut prior to delivery. The RoC Navy soon undid this, however, and obtained equipment from various sources (one of the sonars from France, for example) so that they were soon returned to active status.

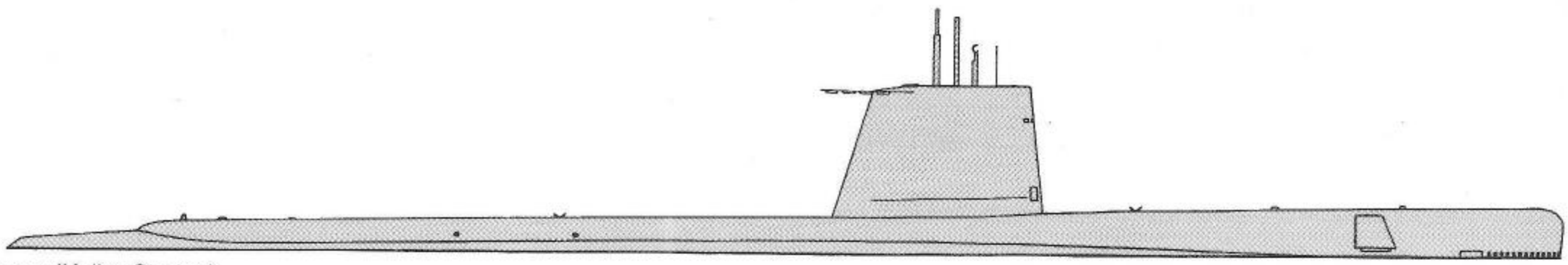
THE FUTURE

These two boats and their equipment are very antiquated and for over a decade the RoC Navy has been seeking to obtain new submarines to replace them. The RoC managed to obtain two submarines from the Netherlands (see 'Hai Lung' class), but that apart, their efforts have been frustrated at every turn by the government in Beijing.

Hai Bao (792)

It is worth noting that *Hai Bao* was one of the products of Cramp Shipbuilding at Philadelphia, a yard that gave the US Navy more problems than all the other yards put together. The yard had been out of business for 14 years when it was reopened in 1940 under the old name, but run by a group of businessmen with no relationship to the previous company. The yard used idiosyncratic management methods and took far longer than any other yard to complete its boats; the navy removed several hulls for completion elsewhere and Cramp boats had a bad reputation throughout the submarine force. Despite this, *Hai Bao,* which as USS *Tusk* (SS 426) was laid down on 23 August 1943 but not launched until 8 July 1945, has outlasted many of its contemporaries which came from yards with a far better reputation.

GUPPY IIA



Guppy IIA (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Turkey

Class: GUPPY IIA

Purchased: 3
In service: 5

Displacement:
surfaced: 1,848 t
submerged: 2,440 t

Dimensions
Length: 93.2 m (306.0 ft)
Beam: 8.2 m (27.0 ft)
Draught: 5.2 m (17.0 ft)

Speed:
surfaced: 17 kts
submerged: 14-15 kts
Range, surfaced: 12,000 n miles at 10 kts

Complement: 85 (9 officers)

SUBMARINES

BURAK REIS (S 335)

Builder	Navy Yard, Portsmouth, New Hampshire, USA
Laid down	2 Nov 1943
Launched	28 Mar 1944
Commissioned	13 Jun 1944 (USS *Sea Fox* (SS 402))
Converted to Guppy IIA	1953
Transferred to Turkey	14 Dec 1970

MURAT REIS (S 336)

Builder	Navy Yard, Portsmouth, New Hampshire, USA
Laid down	9 Sep 1943
Launched	27 January 1944
Commissioned	3 Apr 1944 (USS *Razorback* (SS 394))
Converted to Guppy IIA	1954
Transferred to Turkey	30 Nov 1970

ULUC ALI REIS (S 338)

Builder	Navy Yard, Portsmouth, New Hampshire, USA
Laid down	5 Apr 1944
Launched	7 Jul 1944
Commissioned	13 Oct 1944 (USS *Thornback* (SS 418))
Decommissioned	6 Apr 1946
Converted to Guppy IIA	1953
Recommissioned	2 Oct 1953
Transferred to Turkey	1 Jul 1971

CERBE (S 340)

Builder	Navy Yard, Portsmouth, New Hampshire, USA
Laid down	22 May 1944
Launched	18 Aug 1944
Commissioned	16 Nov 1944 (USS *Trutta* (SS 421))
Decommissioned	1947
Recommissioned	1 Mar 1951
Converted to Guppy IIA	1953
Transferred to Turkey	1 Jul 1972

BIRINCI INONU (S 346)

Builder	Navy Yard, Portsmouth, New Hampshire, USA
Laid down	18 Mar 1944
Launched	26 Jun 1944
Commissioned	30 Aug 1944 (USS *Threadfin* (SS 410))
Converted to Guppy IIA	1953
Transferred to Turkey	18 Aug 1972

WEAPONS SYSTEMS

TUBES

10–533 mm (21 in) (6 bow, 4 stern) tubes.
Total weapon load, 21.

TORPEDOES

Mk 37 Mod 2 torpedoes

These submarines are armed with the Mod 2 wire-guided version of the original type of Mk 37 anti-submarine torpedo, which entered service with the US Navy in about 1967. It is comparatively slow, with two set speeds of either 26 knots or 17 knots, which makes it unsuitable for use against anything other than a slow-moving diesel-electric submarine.

Specifications
Length: 4.09 m (13.4 ft)
Diameter: 483 mm (19 in)
Weight: 766.6 kg (1,690 lb)
Performance: 9,150 m (10,000 yd) at 26 kts, 21,500 m (23,500 yd) at 17 kts
Warhead: 149.7 kg (330 lb)

MINES

40 tube-launched mines can be carried in lieu of torpedoes.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Mk 106 TFCS

The Mk 106 torpedo fire-control system (TFCS) was a simplified version of the Mk 101 TFCS, which was the US Navy's first post-war fire-control system for submarines.

RADAR

SS-2A

SS-2A was one of the earlier US Navy post-war submarine surface search radars. It operates in the I-band and is very dated.

SONARS

EDO BQR-2B

The BQR-2B passive search and attack sonar was installed in most US Navy 'Guppy' class submarines. The hull-mounted, cylindrical array operates at medium frequency (0.5-15 kHz).

Raytheon/EDO BQS-4C

Also of early-1950s vintage, BQS-4C adds an active capability to the BQR-2B. The BQS-4C array consists of seven vertically stacked cylindrical transducers mounted inside the BQR-2C array, with the latter also acting as the BQS-4C's receiver. Operating frequency is 7 kHz.

PROPULSION

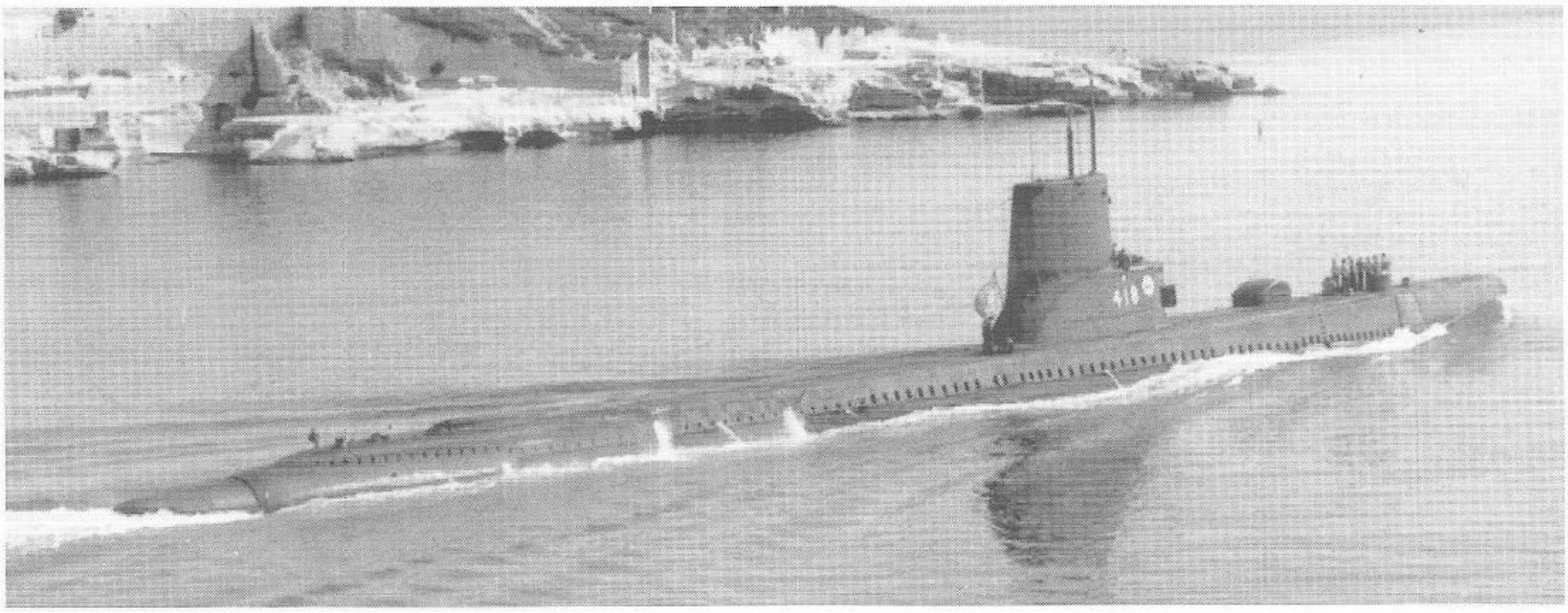
Specifications
System: Diesel-electric
Main Machinery: 3 Fairbanks-Morse 38D8-1/8-10 diesels; 3.3 MW (4,500 hp)

Propulsion motors: 2 Elliott motors; 3.6 MW (4,800 hp)
Shafts: 2

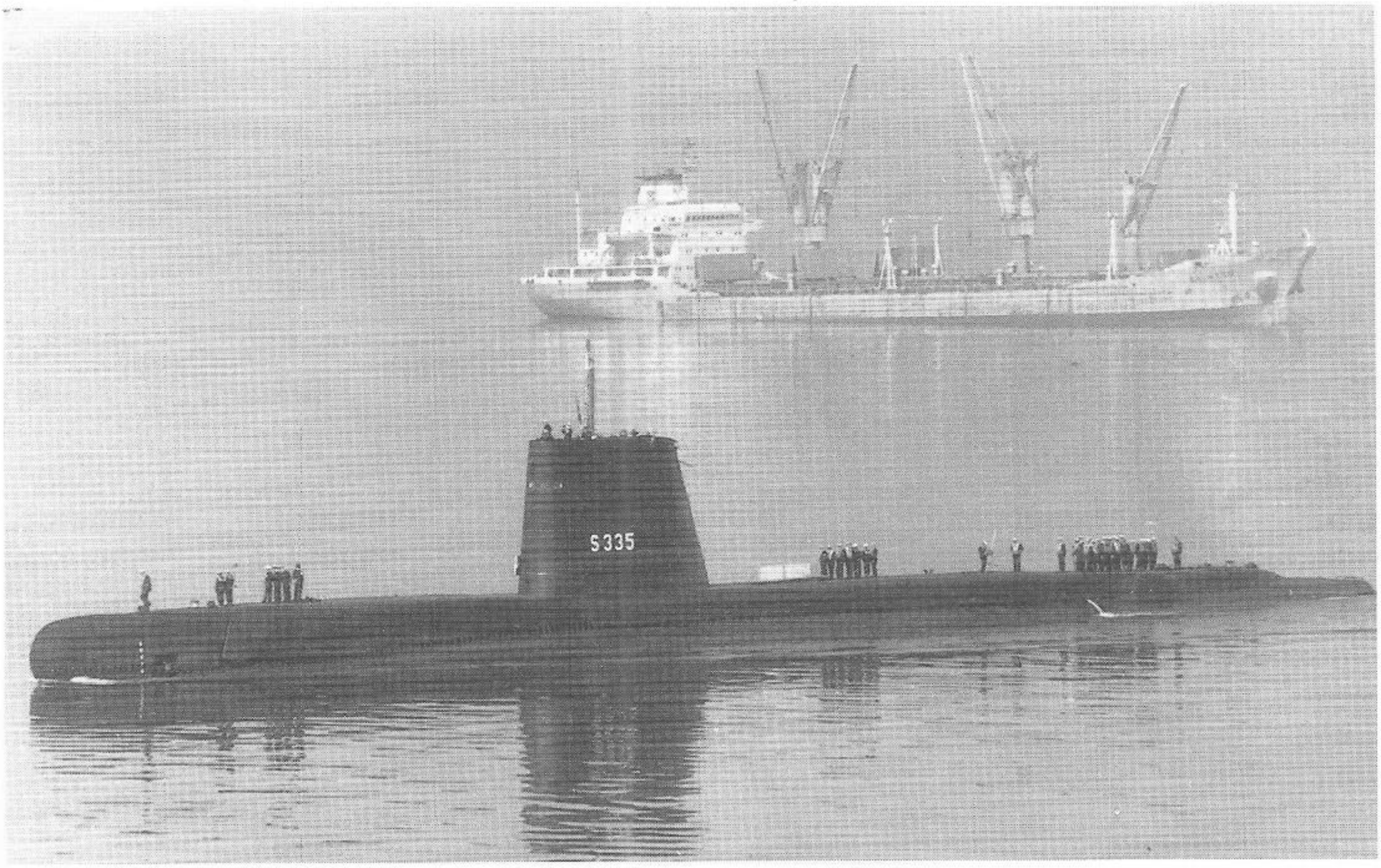
FURTHER INFORMATION

PROGRAMME

The Turkish Navy originally acquired seven Guppy IIAs between 1970 and 1973, but two were stricken in 1987, leaving these five. These boats were originally 'Balao' class (SS 402, SS 394, SS 410) and 'Tench' class (SS 418, SS 421), which were modified to Guppy IIA standard in 1953. *Cerbe* (ex-USS *Trutta)* (SS 421) holds the unusual distinction of being the only remaining 'Guppy' class submarine still in commission to retain the original low bridge, once a feature of all Guppy conversions, which becomes unpleasantly wet during surface passages in heavy seas.

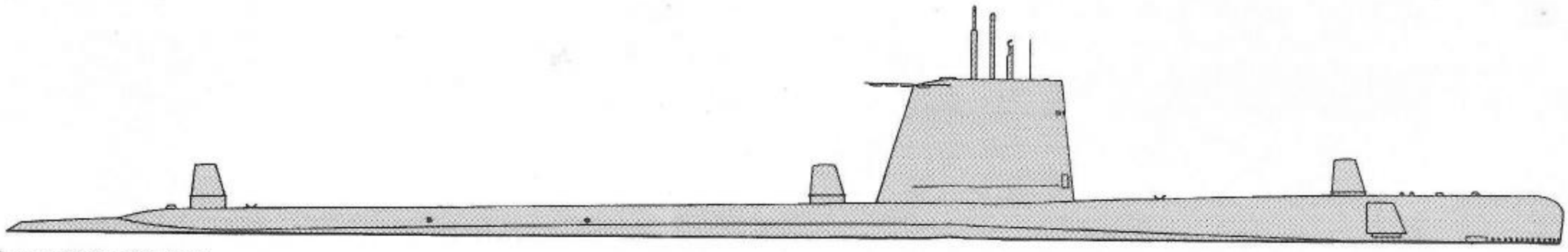


Thornback *(SS 418) as a Guppy IIA in 1957. It first entered service in April 1944, transferred to the Turkish Navy in 1974 and is still in service in 1997* (H & L van Ginderen Collection)



Burakreis *(S 335), formerly* Sea Fox *(SS 402), of the 'Balao' class* (Selim Sam)

GUPPY III



Guppy III (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Turkey
Class: GUPPY III

Purchased: 2
In service: 2

Displacement:
surfaced: 1,975 t
submerged: 2,450 t

Dimensions
Length: 99.5 m (326.5 ft)
Beam: 8.2 m (27 ft)
Draught: 5.2 m (17 ft)

Speed:
surfaced: 17.5 kts
submerged: 15 kts
Range, surfaced: 10,000 n miles at 10 kts

Complement: 86 (8 officers)

SUBMARINES

CANAKKALE (S 341)

Builder	Electric Boat Co, Groton, Connecticut, USA
Laid down	3 Apr 1944
Launched	1 Apr 1945
Commissioned	8 Aug 1945 (USS *Cobbler* (SS 344))
Converted to Guppy II	1949
Converted to Guppy III	1962
Transferred to Turkey	21 Nov 1973

IKINCI INONU (S 333)

Builder	Electric Boat Co, Groton, Connecticut, USA
Laid down	27 Apr 1944
Launched	10 Jun 1945
Commissioned	9 Nov 1945 (USS *Corporal* (SS 346))
Converted to Guppy II	1948
Converted to Guppy III	1962
Recommissioned	21 Nov 1973

WEAPONS SYSTEMS

TUBES

10–533 mm (21 in) (six bow, four stern) tubes.
Total weapon load, 21.

TORPEDOES

Mk 37 Mod 2 torpedoes
These submarines are armed with the Mod 2 wire-guided version of the original type of Mk 37 anti-submarine torpedo, which entered service with the US Navy in about 1967. It is comparatively slow, with two set speeds of either 26 knots or 17 knots, which makes it unsuitable for use against anything other than a slow-moving diesel-electric submarine.

Specifications
Length: 4.09 m (13.4 ft)
Diameter: 483 mm (19 in)
Weight: 766.6 kg (1,690 lb)
Performance: 9,150 m (10,000 yd) at 26 kts; 21,500 m (23,500 yd) at 17 kts
Warhead: 149.7 kg (330 lb)

MINES

40 tube-launched mines can be carried in lieu of torpedoes.

COMMAND AND CONTROL SYSTEMS

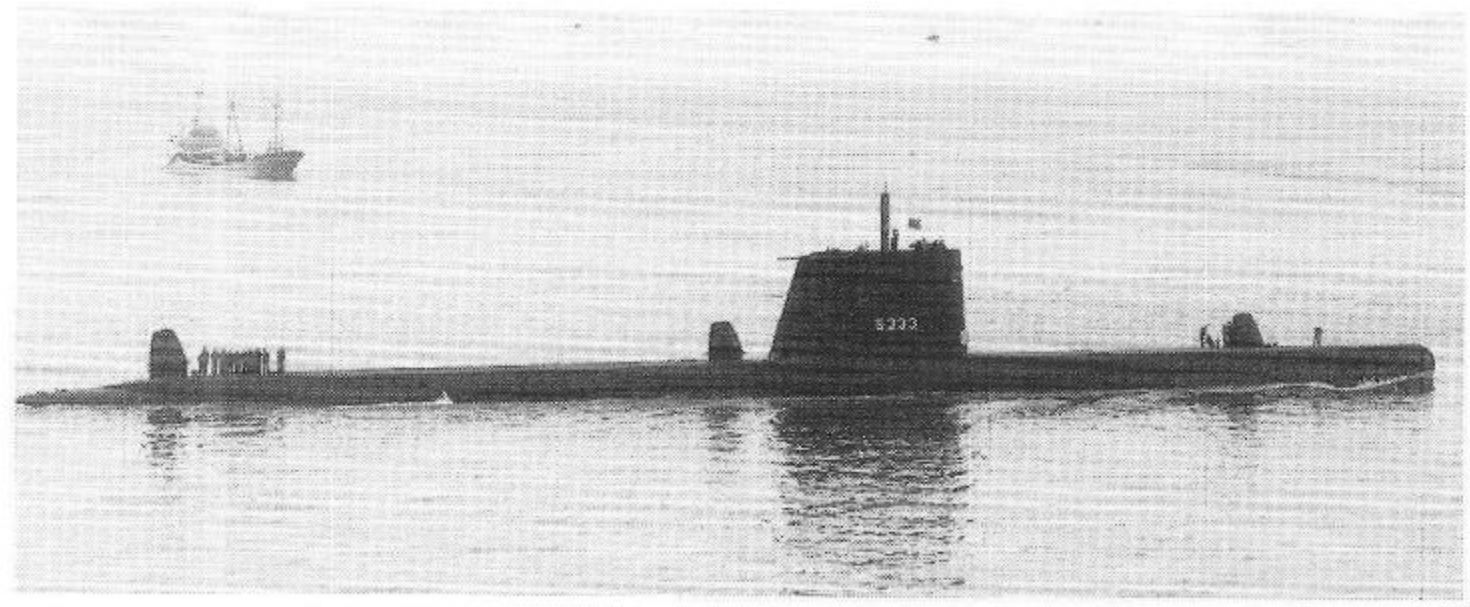
RADAR

SS-2
SS-2 was one of the earlier US Navy post-war submarine surface search radars. It operates in the I-band and is very dated.

SONARS

EDO BQR-2B
The BQR-2B passive search and attack sonar was installed in most US Navy 'Guppy' class submarines. The hull-mounted, cylindrical array operates at medium frequency (0.5-15 kHz).

Sperry/Raytheon BQG 4
The BQG-4 is the system with the visual trademark of three large, fin-shaped sonar transducer domes. These three equally spaced, 1.8 m (6 ft) high transducers form a base line, and the system can locate a target to within a range accuracy of 95 per cent and a bearing accuracy of 0.5° to a range in the order of 13,700 m (15,000 yd)



Ikinci Inönü *(S 333) a former 'Balao' class Guppy III conversion* (Selim San)

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 4 General Motors GM 16-278A diesels; 4.41 MW (6,400 hp)
Propulsion motors: 2 General Electric motors; 4.2 MW (5,600 hp)
Shafts: 2

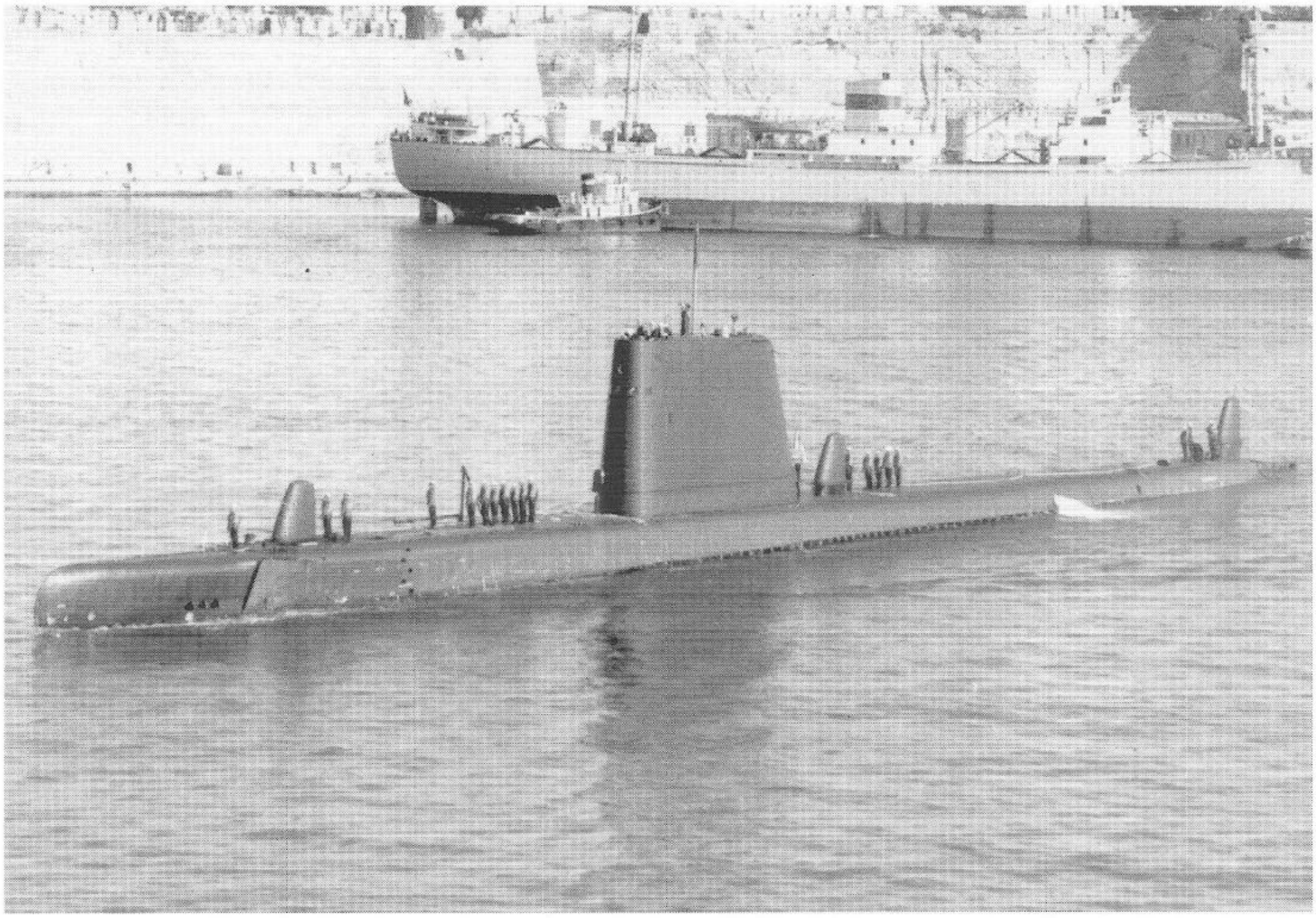
FURTHER INFORMATION

PROGRAMME

These are two former 'Balao' class submarines, which were initially converted to Guppy IIs in 1948 and then to Guppy IIIs in 1962, the latter job requiring them to be lengthened by some 4.6 m (15 ft). They were transferred to Turkey in November 1973.

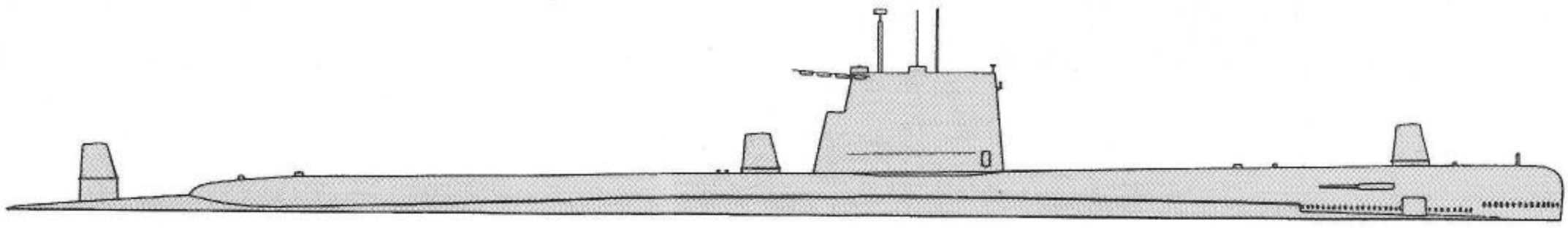
OPERATIONAL

It is reported that their diving may now be restricted to periscope depth.



Cobbler *(SS 344) in US service in 1970, was transferred to Turkey in 1973, becoming* Canakkale *(S 341)* (H & L van Ginderen Collection)

TANG



Tang (Ian Sturton)

GENERAL SPECIFICATIONS

Country: Turkey

Class: TANG

Purchased: 2
In service: 2

Displacement:
surfaced: 2,100 t
submerged: 2,700 t

Dimensions
Length: 87.4 m (287 ft)
Beam: 8.3 m (27.3 ft)
Draught: 5.8 m (19 ft)

Speed:
surfaced: 16 kts
submerged: 16 kts
Range, surfaced: 7,600 n miles at 15 kts

Complement: 87 (8 officers)

SUBMARINES

HIZIR REIS (S 342)

Builder	Navy Yard, Portsmouth, New Hampshire, USA
Laid down	20 May 1950
Launched	11 Jun 1952
Commissioned	21 Nov 1952 (USS *Gudgeon* (SS 567))
Leased to Turkey	Sep 1983
Recommissioned	30 Sep 1983
Purchased by Turkey	Jun 1987

PIRI REIS (S 343)

Builder	Navy Yard, Portsmouth, New Hampshire, USA
Laid down	18 Apr 1949
Launched	27 Apr 1952
Commissioned	25 Oct 1952 (USS *Tang* (SS 563))
Leased to Turkey	Jan 1980
Recommissioned	21 Apr 1980
Purchased by Turkey	Jun 1987

WEAPONS SYSTEMS

TUBES

Eight 533 mm (21 in) (six forward, two aft).
Total weapon load, 21.

TORPEDOES

Mk 37 Mod 2 torpedoes

These submarines are armed with the Mod 2 wire-guided version of the original type of Mk 37 anti-submarine torpedo, which entered service with the US Navy in about 1967. It is comparatively slow, with two set speeds of either 26 knots or 17 knots, which makes it unsuitable for use against anything other than a slow-moving diesel-electric submarine.

Specifications
Length: 4.09 m (13.4 ft)
Diameter: 483 mm (19 in)
Weight: 766.6 kg (1,690 lb)
Performance: 9,150 m (10,000 yd) at 26 kts; 21,500 m (23,500 yd) at 17 kts
Warhead: 149.7 kg (330 lb)

MINES

40 tube-launched mines can be carried in lieu of torpedoes.

Piri Reis *(S 343) is the former* Tang *(SS 563), nameship of its class. The PUFFS fins are very obvious in the view* (H & L van Ginderen Collection)

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Mk 106 TFCS

The Mk 106 torpedo fire-control system (TFCS) was a simplified version of the Mk 101 TFCS, which was the US Navy's first post-war fire-control system for submarines.

RADAR

Fairchild BPS 12

BPS-12 is a modified version of the BPS-5 I-band search radar for submarines.

SONARS

EDO BQR 2B

The BQR-2B passive search and attack sonar was installed in most US Navy 'Guppy' class submarines. The hull-mounted, cylindrical array operates at medium frequency (0.5-15 kHz).

Raytheon/EDO BQS-4C

Also of early-1950s vintage, BQS-4C adds an active capability to the BQR-2B. The BQS-4C array consists of seven vertically stacked cylindrical transducers mounted inside the BQR-2C array, with the latter also acting as the BQS-4C's receiver. Operating frequency is 7 kHz.

Sperry/Raytheon BQG 4

The BQG-4 is the system with the visual trademark of three large, fin-shaped sonar transducer domes. These three equally spaced, 1.8 m (6 ft) high transducers form a base line, and the system can locate a target to within a range accuracy of 95 per cent and a bearing accuracy of 0.5° to a range in the order of 13,700 m (15,000 yd)

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 3 Fairbanks-Morse 38D8-1/8-10 diesels; 3.3 MW (4,500 hp)

Propulsion motors: 2 Elliott motors; 4.2 MW (5,600 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

Following their service in the US Navy, the first two 'Tang' class to go were sold to Italy in 1973/74. Agreement was then reached to sell three to the Imperial Iranian Navy for use in training a submarine arm as part of the Shah's plan for Iran to dominate the Gulf. The revolution put paid to that plan, however, and two of the submarines involved in the deal were eventually scrapped. One, however, *Tang* (SS 563) was then diverted to Turkey where it was followed by *Gudgeon* (SS 567); both were initially on loan, but were purchased by Turkey in 1987.

Piri Reis *(S 343) in 1982* (H & L van Ginderen Collection)

HEROJ

GENERAL SPECIFICATIONS

Country: Yugoslavia

Class: HEROJ

Built: 3
In service: 2

Displacement:
surfaced: 615 t
submerged: 705 t

Dimensions
Length: 50.4 m (165.4 ft)
Beam: 4.7 m (15.4 ft)
Draught: 4.5 m (14.8 ft)

Speed:
surfaced: 10 kts
submerged: 15 kts
Diving depth: 150 m (500 ft)

Range:
surfaced: 9,700 n miles at 8 kts
submerged: 4,100 n miles at 10 kts

Complement: 31

SUBMARINES

HEROJ (821)

Builder	Uljanik Shipyard, Pula, Croatia
Laid down	1964
Launched	1967
Commissioned	1968

USKOK (823)

Builder	Uljanik Shipyard, Pula, Croatia
Laid down	1966
Launched	1969
Commissioned	1970

WEAPONS SYSTEMS

TUBES

Four 533 mm (21 in) bow tubes.
Total weapon load, six torpedoes.

TORPEDOES

SET-65E Torpedoes
These Russian-built torpedoes, the export version of the ET80-67, were supplied to the former Yugoslav Navy.

Specifications
Length: 7.8 m (25.6 ft)
Diameter: 533 mm (21 in)
Role: ASW
Propulsion: Electric
Performance: 8.1 n miles (15 km) at 40 kts
Homing: Active/passive
Warhead: 205 kg (452 lb)

MINES

12 Soviet-supplied mines can be carried in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Stop Light
Stop Light is a Soviet-supplied, broadband passive radar warning (ESM) system, which probably also includes an ELINT function.

COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Group
Soviet-supplied surface search radar; I-band.

SONAR

These submarines are fitted with a sonar but the type is not certain.

Heroj (821) was reported for many years to have a submerged displacement of 945 t, but this is now known to be 705 t

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 Rade Koncar diesel generators; 880 kW (1,200 hp(m))

Electric motor: 1 motor; 1.15 MW (1,560 hp(m))
Auxiliary motor: 1
Shafts: 1

FURTHER INFORMATION

PROGRAMME

The first Yugoslav-designed submarines were the two boats of the 'Sutjeska' class, built at the Uljanik Yard at Pola and completed in 1960-62 and stricken in 1987. Displacing 945 t (submerged) they had Sulzer diesels and Soviet electronics. The 'Heroj' class was built between 1964 and 1970. The second boat built, *Junak* (822), was commissioned in 1969 and was placed in reserve and cannibalised for spares before being stricken in 1995.

DESIGN

Recent information reveals that these submarines are appreciably smaller than was previously thought:

	1985 information	1996 information
Displacement		
surfaced	820 t	615 t
submerged	945 t	705 t

	1985 information	1996 information
Dimensions		
length	60 m (196.8 ft)	50.4 m (165.4 ft)
beam	6.8 m (22.3 ft)	4.7 m (15.4 ft)
draught	4.9 m (16.1 ft)	4.5 m (14.8 ft)
Torpedo tubes	6	4
Crew	55	31

It should be noted that the number of torpedo tubes (four) and the total weapon load carried (six) are among the smallest of any operational submarine.

OPERATIONAL

Uskok was operational throughout 1995 and 1996, while *Heroj* continues in refit in Tivat. It is possible that the upheavals since the break-up of Yugoslavia have prevented the training of replacement crews. It is worth noting that the submarines are being operated by the navy of Serbia but that the submarine construction yards are in Croatia and that the majority of men in the submarine service were traditionally from Croatia. The new owners may, therefore, be having difficulty keeping the submarines operational

These boats are capable of only short periods at sea and are probably restricted to Adriatic waters. In fact, they are essentially coastal submarines with limited endurance and operational capability. Nevertheless, they pose a threat to the UN/NATO warships in the Adriatic which cannot be ignored.

SAVA

GENERAL SPECIFICATIONS

Country: Yugoslavia

Class: SAVA

Built: 2
In service: 2

Displacement:
surfaced: 830 t
submerged: 960 t

Dimensions
Length: 55.7 m (182.7 ft)
Beam: 7.2 m (23.6 ft)
Draught: 5.1 m (16.7 ft)

Speed:
surfaced: 10 kts
submerged: 16 kts
Diving depth: 300 m (980 ft)

Complement: 35

SUBMARINES

SAVA (831)

Builder	S and DE Factory, Split, Yugoslavia
Laid down	1975
Launched	1977
Commissioned	1978

DRAVA (832)

Builder	S and DE Factory, Split, Yugoslavia
Laid down	1978
Launched	1980
Commissioned	1981

WEAPONS SYSTEMS

TUBES

Six 533 mm (21 in) bow tubes.
Total weapon load, 10.

TORPEDOES

TEST-71ME
Up to ten of the Soviet-supplied TEST-71ME (export version of the TEST-71) can be carried.

Specifications
Role: ASW
Length: 7.9 m (25.92 ft)
Diameter: 533 mm (21 in)
Propulsion: Electric
Performance: 8.1 n miles (15 km) at 40 kts
Guidance: Active/passive; wire-guided
Warhead: 205 kg (452 lb)

MINES

20 mines, presumably Soviet-supplied, can be carried in lieu of torpedoes.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Stop Light
Stop Light is a Soviet-supplied, broadband passive radar warning (ESM) system, which probably also includes an ELINT function.

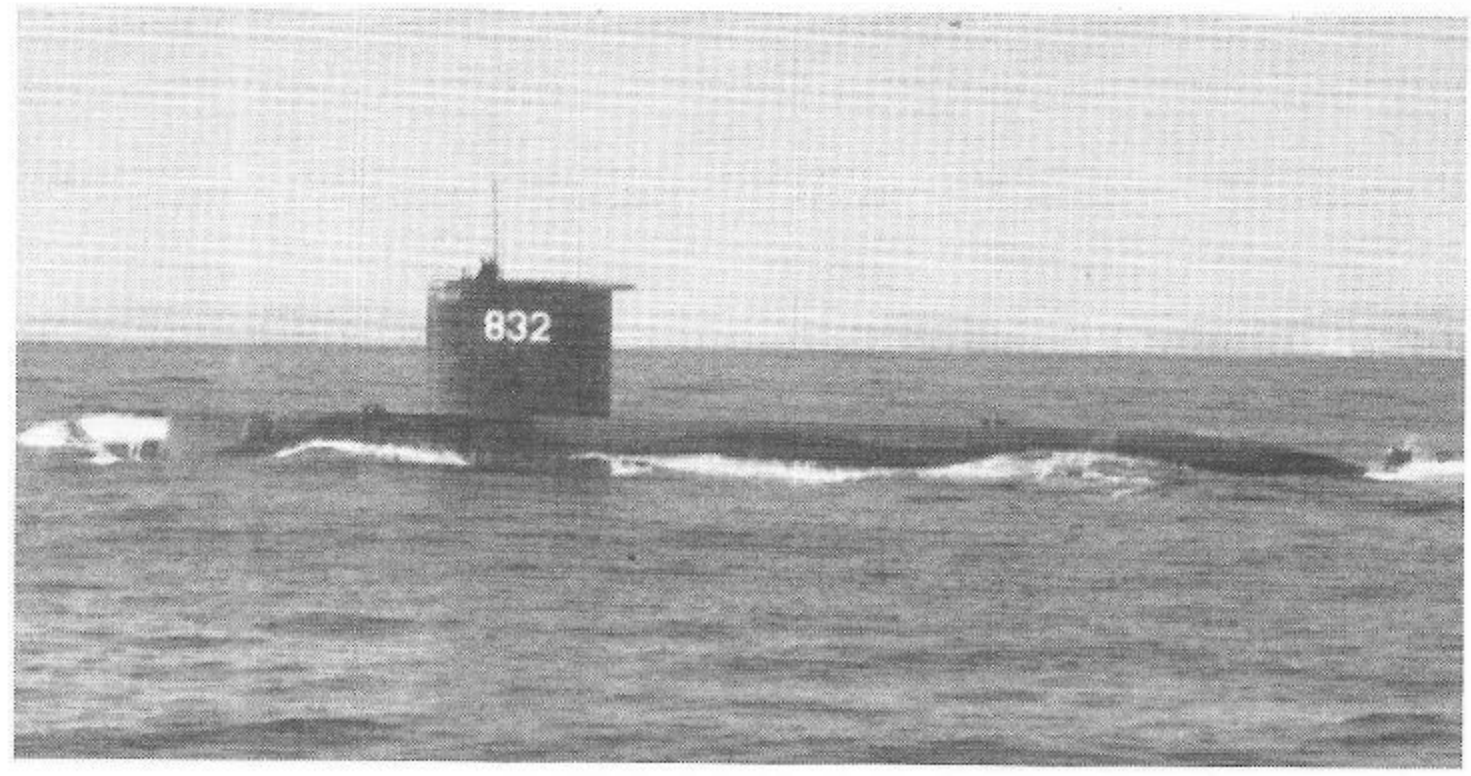
COMMAND AND CONTROL SYSTEMS

RADAR

Snoop Group
Soviet-supplied surface search radar; I-band.

SONAR

Herkules
Herkules was the standard Soviet active/passive search sonar for many years. Hull-mounted, it operates at medium frequencies and is usually mounted in combination with a Feniks attack sonar.



One of the two 'Sava' class is in refit, suggesting that they will both remain in service for some years to come (Yugoslav Navy)

PROPULSION

Specifications
System: Diesel-electric
Main Machinery: 2 Sulzer diesels; 1.18 MW (1,600 hp(m))

Generators: 2 generators; 1 MW
Electric motor: 1 motor; 1.5 MW (2,040 hp(m))
Shaft: 1

FURTHER INFORMATION

PROGRAMME

The two 'Sava' class boats are enlarged and improved versions of the 'Heroj' class. They were built with Soviet electronic equipment and armament, although the sonar has subsequently been replaced by a German STN Atlas system.

DESIGN

The boats are of conventional, twin-hull design, with a pressure hull 42.7 m (140.1 ft) long and 5.05 m (15.57 ft) in diameter. The casing is made of GRP. The accommodation is poor.

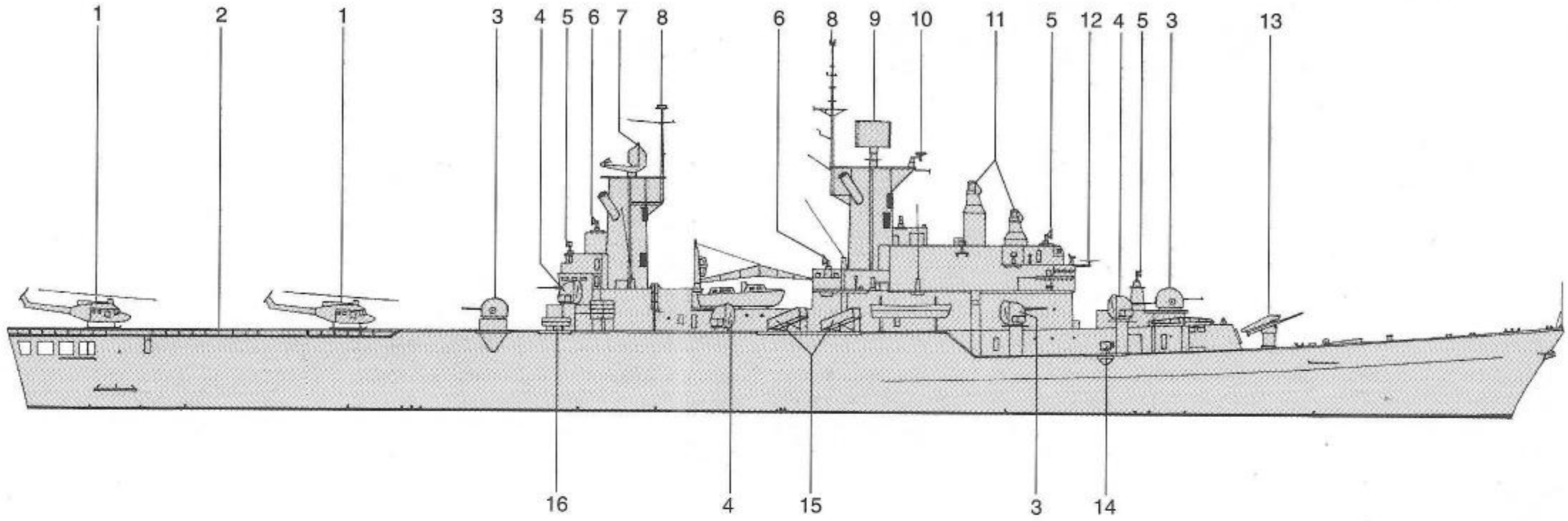
OPERATIONAL

One was operational in early 1996, while the second was in refit at Tivat.

Despite being larger than the 'Heroj' class, it would appear that the 'Sava' class is also intended for coastal operations of limited duration in the Adriatic Sea.

CRUISERS (CGN/CG)

VITTORIO VENETO



Vittorio Veneto (Ian Sturton)
1 *AB-212 ASW (6 carried)* **2** *Flight deck; 40 × 18.6 m (131 × 61 ft)* **3** *OTOBREDA twin 40 mm/70 'Fast Forty'* **4** *OTOBREDA single 76 mm (3 in)/62* **5** *Alenia SPG 74 (RTN-20X) radar* **6** *Alenia SPG 70 (RTN-10X) radar* **7** *Alenia SPS 768 (RAN 3L) radar* **8** *EW array* **9** *Hughes AN/SPS 52C radar* **10** *SMA SPS 702* **11** *Sperry/RCA AN/SPG 55C radar* **12** *SMA SPS 748* **13** *Aster twin Mk 10 Mod 9 launcher (for standard SM-1ER)* **14** *OTOBREDA SCLAR decoy launcher* **15** *OTOBREDA Teseo Mk 2 SSM launchers* **16** *Triple Mk 32 324 mm torpedo tubes*

GENERAL SPECIFICATIONS

Operator: Italy
Type: Guided-missile cruiser/helicopter carrier (CGH)

Class: VITTORIO VENETO

Built: 1
Active: 1

Displacement:
standard: 7,500 t
full load: 9,500 t

Dimensions
Length: 179.6 m (589 ft)
Beam: 19.4 m (63.6 ft)
Draught: 6 m (19.7 ft)

Speed: 32 kts
Range: 5,000 n miles at 17 kts

Complement: 557 (53 officers)

SHIPS

VITTORIO VENETO (C 550)

Builder	Italcantieri, Castellamare, Italy
Laid down	10 Jun 1965
Launched	5 Feb 1967
Commissioned	12 Jul 1969

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Standard Missile-1 Medium Extended (SM-1ER)

Vittorio Veneto's principle air defence system is the Standard SM-1ER (ER = Extended Range), for which there is a single, twin-arm Aster Mk 10 Mod 9 launcher on the foredeck with a 60 missile magazine below (the system also handles and launches ASROC missiles (see below)). The Standard SM-1ER was developed from the SM-1MR but has a larger rocket motor, giving it much improved range. The missile has a Raytheon conical scan, solid-state, semi-active radar seeker with scan receiver, speed gate and analogue guidance computer, and the Naval Weapon Center Mk 90 blast fragmentation warhead in the ordnance section. The missile is powered by an Aerojet Mk 56 Mod 1 dual-thrust rocket motor, which gives substantially improved range and altitude performance over the MR version, and an ARC Mk 30 Mod 1 sustainer.

The fire-control system uses two SPG-55C radars, which are positioned *en echelon* above the bridge.

Specifications
(SM-1ER)
Length: 7.98 m (26.2 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.57 m (5.15 ft)
Weight: 1,343.6 kg (2,962 lb)
Speed: Mach 2.5
Range: 34.5 n miles (64 km)
Altitude: 24,400 m (80,000 ft)

Manufacturers/Contractors
Hughes Missile Systems Company.
Raytheon Missile Systems Division.

Vittorio Veneto *in its original state, shortly after commissioning. Two standard missiles are on the twin-arm launcher, but at this stage the Breda 40 mm 'Fast Forties' had not been mounted* (H & L van Ginderen Collection)

ANTI-SHIP MISSILES

OTOBREDA Teseo Mk 2 (TG 2)

There are four missiles, housed in individual containers, mounted in the ship's waist at an angle of 15°, with the missile suspended from a ceiling launch rail. The Teseo system is based on the Otomat missile, which has folding wings and is powered by a turbojet with solid fuel rocket boosters. The warhead is a semi-armour-piercing type, which is claimed to penetrate up to 8 cm (3 in) of nickel-chromium armour.

The Mk 2 system used in *Vittorio Veneto* is capable of over-the-horizon targeting in which the missile flies towards the helicopter, normally an Agusta-Bell AB 212ASW with SMA MM/APS-705 I-band radar and PRT-405 tracking and datalink system. Only when the missile passes under the helicopter does the latter transmit target location data.

Vittorio Veneto. *The sensors above the bridge are Selenia (now Alenia) SPG 70 fire control for guns (small circular antenna); two SPG 55C fire control for missiles (large conical devices); SPS 702 (small rectangular array) used for surface search and fire control; and the large black rectangular array for the Hughes SPS 52C. At the head of the after mack is the antenna for the SPS 768 air search radar* (Camil Busquets i Vilanova)

The target may be acquired by the ship's radar, by the radars of friendly ships or by helicopter radars. Data on the target's location are transmitted to the missile's autopilot and the turbojet is started. Once it has reached full power the boosters are ignited and the missile is launched, but as the missile can turn through angles of up to ±200° the warship does not have to be facing the target during the launch phase.

Once launched, the missile climbs to 150 m (492 ft), accelerated by the boosters which burn for 4 seconds until it reaches cruising speed at a distance of some 2.15 n miles (4 km) from the launch point, where the boosters are jettisoned. The missile then descends to a cruising altitude of 15-20 m (49-65 ft), a compromise between ensuring good communications with the mothership and the need to make it difficult for the target to detect. The missile continues towards the target with mid-course guidance correction until the radar seeker, which is azimuth only, is activated at a predetermined point and scans a 40° sector, then acquires the target at a range of about 6.5 n miles (12 km). For the terminal phase the Otomat drops to sea-skimming height.

The Otomat system is capable of engaging two separate targets simultaneously in sea states up to Force 7.

Specifications

Length:
Otomat Mk 1: 4.66 m (15.29 ft)
Otomat Mk 2: 4.46 m (14.63 ft)
Diameter: 46 cm (18 in)
Wing span: 1.36 m (4.46 ft)
Weight:
without boosters: 762 kg (1,680 lb)
with boosters: 770 kg (1,698 lb)
Range: 86 n miles (160 km)
Guidance: Inertial and active radar homing
Propulsion: Turbomeca TR 281 Arbizon III turbojet; 400 kg st
Boosters: 2 SNPE solid propellant boosters; 3,500 kg st each
Warhead: Semi-armour-piercing; 210 kg (463 lb)/ HE 65 kg (143 lb)
Fuzes: Impact, proximity

Manufacturer/Contractor

OTOBREDA, Italy.

TUBES

Six 324 mm (12.75 in) US Mk 32 (two triple) torpedo tubes are sited aft, outboard of the after end of the hangar.

Specifications

Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

Manufacturer/Contractor

GEC-Marconi Naval Systems, UK.

TORPEDOES

Alliant Techsystems Mk 46 Mod 2 324 mm torpedoes

Specifications

Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 232 kg (511.5 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: Monopropellant
Speed: 45 kts
Range: 4.5 n miles (8.33 km)
Acquisition range: 460 m (1,510 ft) (estimated)

Honeywell RUR-5A ASROC

ASROC remains in service with the Italian Navy and in *Vittorio Veneto* the Standard SM-1ER and ASROC missiles share the magazine and the Aster twin-arm launcher. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 460 m (1,510 ft).

When a submarine target is detected by *Vittorio Veneto's* SQS-23 sonar it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m, although the aerodynamically stable airframe enables it to coast up to 600 m (1,968.6 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and, as they separate, the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications

ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Wing span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.76 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid monopropellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg; PBXN-103 (97 lb)

Manufacturer/Contractor

Honeywell Inc, Training and Control Systems Operations.

GUNS

OTOBREDA 76 mm (3 in)/62 MMI

There are eight OTOBREDA 76 mm (3 in)/62 calibre MMI (*Marina Marittimo Italiana*) guns in single turrets, four each at the forward and after ends of the superstructure. They are controlled by the Argo fire-control system.

Specifications

Elevation: −15 to +85°
Training speed: 70°/s
Elevation speed: 40°/s
Weight (unloaded): 12 t
Muzzle velocity: 900 m/s (2,953 ft/s)
Rate of fire: 59 rds/min
Range: 8.5 n miles (15.75 km)

Vittorio Veneto *in 1995. The Aster Mk 10 Mod 9 twin-arm launcher is on the foredeck with 60-missile magazine for standard SM-1ER behind it. The heavy gun armament is also evident. Two twin 40 mm Bredas can be seen, one atop the missile magazine and a second aft at the forward end of the flight deck. The other turrets are for single 76 mm (3 in) OTOBREDA guns* (Italian Navy)

OTOBREDA twin 40 mm/70

The three twin Breda 40 mm mounts are located one forward and two aft on sponsons either side of the flight deck.

Specifications

Calibre: 40 mm
Length of barrel: 70 calibres
Muzzle velocity:
PFHE: 1,025 m/s (3,362 ft/s)
APFSDS: 1,350 m/s (4,429 ft/s)
Traverse: 360°
Elevation: −13 to +85°
Traverse speed: 90°/s
Elevation speed: 60°/s
Range:
anti-surface: 6.75 n miles (12.5 km)
anti-air: 8,700 m (28,500 ft)
Rate of fire: 900 rds/min
Ammunition:
PFHE: 2.4 kg (5.3 lb)
APFSDS: 2.5 kg (5.5 lb)

Manufacturer/Contractor

Breda Meccanica Bresciana, I-25128 Brescia, Italy.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

SLR 4

SLR 4 is the ESM component of *Vittorio Veneto's* ECM suite.

ELECTRONIC COUNTERMEASURES (ECM)

OTOBREDA 105 mm Rocket Launcher (SCLAR)

The SCLAR 105 mm (4.14 in) rocket launcher system provides defence against radar and IR homing missiles, confuses enemy radars, and provides illumination for visual fire control at night.

Different types of rockets can be loaded in various arrangements (long-range chaff, medium-range chaff, illuminating) to permit mixed salvos. The remote fire-control unit is used to select the number and types of rockets to be loaded and to set the fuzes and carry out the launch sequence. In *Vittorio Veneto* there are two 20-tube launchers mounted on each side of the ship abreast the bridge, which are trained and elevated by remote control. The control unit is linked to the ship's radar and a control panel in the ECM compartment to provide the necessary operating signals. The data needed to stabilise the two launchers against pitch and roll is provided by the ship's gyrocompass.

There are four types of rocket which have double-base propellant motors, folding fins and electronic fuzes, while their speed to burnout is 260-645 m/s (853-2,116 ft/s). These rockets are listed in the following table:

Specifications

Launcher
Traverse: 300° at 60°/s
Elevation: −5 to +60° at 30°/s
Number of tubes: 20
Diameter: 105 mm (4.14 in)
Rate of fire: 1 rd/s (approx)

Rockets

Rocket	Role	Range	Length	Weight of complete round	Payload
SNIA 105 LR-C	Chaff distraction	12,000 m (13,120 yd)	1.85 m (6.07 ft)	27 kg (60 lb)	10.2 kg (22.5 lb)
SNIA 105 MR-C	Chaff seduction	4,700 m (5,140 yd)	1.83 m (6.0 ft)	29 kg (64 lb)	17.4 kg (38.4 lb)
SNIA 105 MR-IR	Infra-red seduction	5,000 m (5,470 yd)	1.83 m (6.0 ft)	29 kg (64 lb)	10.2 kg (22.5 lb)
SNIA LR-I	Illuminating	4,000 m (4,370 yd)	1.85 m (6.07 ft)	27 kg (60 lb)	10.2 kg (22.5 lb)

Manufacturer/Contractor
OTOBREDA, Rome, Italy (launcher).
SNIA BPD (rockets).

AN/SLQ-25 Nixie noisemaker
One AN/SLQ-25 Nixie (Phase 1), a solid-state, modular design electroacoustic countermeasures decoy system is used to protect the ship from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads and the transmitter are located. Each winch can stream and recover the 488 m (1,600 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 95 cm long (3.10 ft), 15.24 cm (6 in) in diameter and weigh 18 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body at a time is deployed.

Manufacturer/Contractor
Aerojet ElectroSystems, Sacramento, California, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

SADOC 1
SADOC 1 (SADOC = *Systema Direzione della Operazioni di Combattimento)* was the first Italian Navy computerised command system, designed to produce an up-to-date picture of the tactical situation within the vicinity of both the ship and task group and uses a mainframe architecture to acquire, process and present data acquired by sensors. It is also used for threat evaluation, weapons control, ECM management, aircraft control, conducting ASW operations, and datalink databank management. Data are received from onboard sensors and also from offboard sensors via Link 11.

Manufacturer/Contractor
Alenia Elsag Sistemi Navali, Rome, Italy.

COMMUNICATIONS

Satcom
Link 11.
IFF: Mk XII
TACAN: URN-20

WEAPONS CONTROL

Argo 10 gun control system
There are four Argo 10 systems, one for each pair of 76 mm guns. Argo 10 is designed for surface engagement, air engagements or shore bombardments and can control three guns of two calibres simultaneously, using an RTN 10X fire-control radar. The system is operated through the Main Control Unit (MCU), a console with a ballistic computer, which is used for target acquisition, tracking and engagement either manually or automatically. Two periscopic sights may also be used to provide supplementary target data input to the radar and permit a second target to be engaged. In addition to target data input the MCU receives information from the true wind computer, and data on ship course and speed from the log and gyrocompass, while a vertical reference system provides roll and pitch information.

Manufacturer/Contractor
Alenia Elsag Sistemi Navali, Italy.

Dardo weapon control system
Dardo is an automatic CIWS, with manual override, designed to engage sea-skimming and diving missiles as well as manned aircraft. It is a digital system, using a mainframe computer and the Orion RTN 20X radar. Each system controls a single twin 40 mm gun mounting and optional equipment includes optical designators.

The software is written in Assembler language and, in addition to input from the sensors, there are inputs from the gyrocompass, inertial reference, the log and the wind reference unit. Initial target acquisition is by the ship's search radar which interfaces directly with the system which is also linked to the tactical data handling system. Once the RTN 20 radar has acquired the target/targets the system tracks them automatically, assigning priorities where necessary, although the operator can override the system to engage lower priority targets, if necessary. Targets can be engaged at distances of 300-3,500 m and up to 10 may be tracked simultaneously.

SONAR

Sangamo SQS 23G
The SQS-23 dates from 1958 and is a bow-mounted, active, search and attack sonar, operating at medium frequency (5 kHz)

RADARS

Set	SPS-52C	SPS-768 (RAN-3L)	SPS-702	SPS-748	SPG-70 (RTN-10X)	SPG-74 (RTN-20X)	SPG-55C
Company	Hughes	Selenia	SMA	SMA	Selenia	Selenia	Sperry
Role	Long-range air search	Air search	Surface search, target indication	Navigation	Fire control (Argo)	Fire control (Dardo)	Fire control (Standard)
Band	E/F	D	I	I	I/J	I/J	G/H
Range	240 n miles (440 km)	120 n miles (220 km)		40 n miles (73 km)	22 n miles (40 km)	7 n miles (13 km)	28 n miles (51 km)
Beam	1.1 × 2.25°	2.15 × 9° plus csc²	0.6°	—	—	—	1.6/0.8°
Peak power	1,000 kW	135 kW	Tac: 180 kW Nav: 50 kW	—	200 kW	200 kW	1 MW
Gain	39.5 dB	30 dB		—	—	—	39 dB
Pulsewidth	2.5/4.6/10 µs	78.4 (1.6) µs	Tac: 0.3/1.0/1.6 µs Nav: 1.1 µs	—	1.5 µs	1.5 µs	26/1.5 µs
PRF	1,850/925 pps		Tac: various Nav: 1,000/ 1,028 pps	—	450-550 pps	450-550 pps	203-225 pps
Scan rate	15/6 rpm	6 rpm	15 rpm	—	—	—	—

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 40 × 18.6 m (131 × 61 ft)
Elevators: 2, each 18 × 5.3 m (59 × 17 ft)

HELICOPTERS

Agusta-Bell AB 212ASW

Six Agusta-Bell AB 212ASW anti-submarine, anti-ship or electronic warfare helicopters are normally embarked.

Specifications
Main rotor diameter: 14.63 m (48.0 ft)
Length overall (both rotors turning): 22.15 m (57.08 ft)
Fuselage length: 12.92 m (42.39 ft)
Height to rotor head: 3.91 m (12.82 ft)
Rotor disc area: 168.1 m² (1,809 sq ft)
Max take-off weight: 5,070 kg (11,177 lb)
Max speed (never exceed): 130 kts (240 km/h)
Typical cruising speed: 100 kts (185 km/h)
Hovering ceiling (out of ground effect): 396 m (1,300 ft)
Range with max standard fuel: 332 n miles (615 km)
Engine: 1 Pratt & Whitney Canada PT6T-6 Turbo Twin-Pac rated at 1,398 kW (1,875 shp)
Role equipment: AS-12 ASMs or Elettronica Gufo 2000 EW intercept equipment

Pilot's view of the flight deck of Vittorio Veneto *with two AB-212s already on their landing spots* (NATO/AFSOUTH)

PROPULSION

Specifications
System: Steam
Main machinery: 4 Foster-Wheeler boilers (Ansaldo); 50 kg/cm² (700 psi); 450°C (850°F)
Steam turbines: 2 Tosi turbines; 54 MW (73,000 hp(m))
Shafts: 2

FURTHER INFORMATION

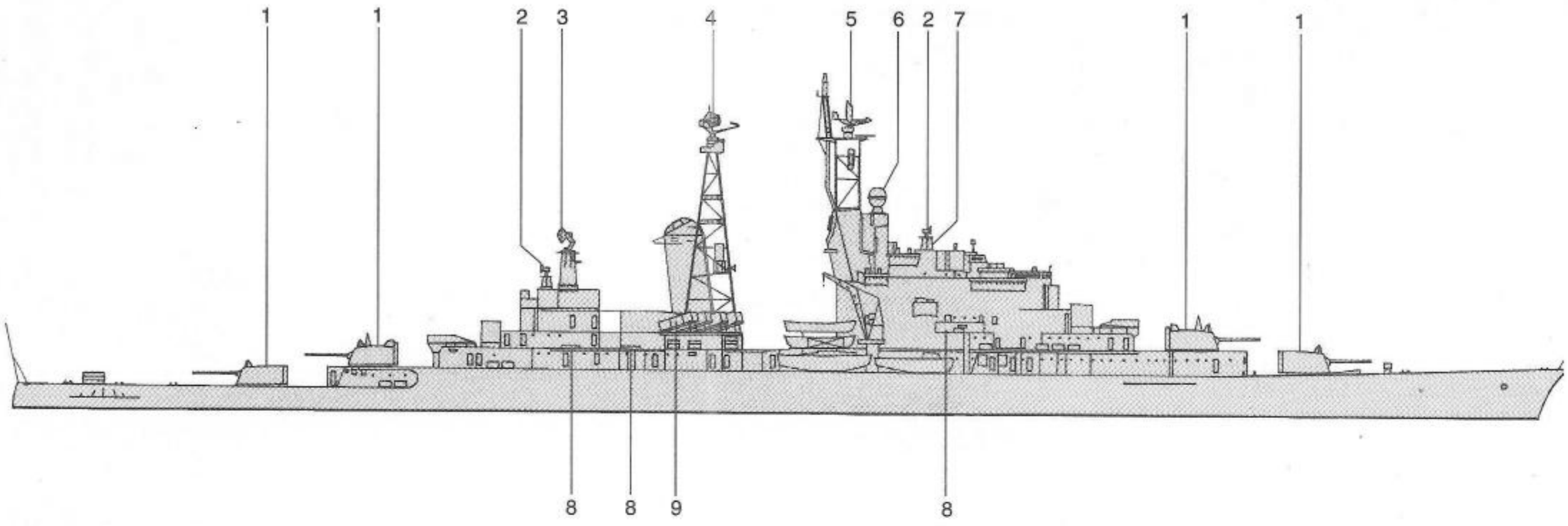
PROGRAMME

Vittorio Veneto is now one of the last hybrid cruiser/ASW helicopter carriers, which were fashionable in the 1950s and 1960s, and included such types as the British 'Tiger' class and the Russian 'Moskva' class. The Italian Navy had built two 'Andrea Doria' class helicopter cruisers between 1958 and 1963, and there was originally intended to be a third of class, to be produced under the 1959-60 New Construction Programme. Operational experience quickly showed that the Doria design was too small, however, and the design of the third ship was recast several times, resulting eventually in *Vittorio Veneto,* which is considerably larger, with a larger flight deck and an air wing of six helicopters, as opposed to just four in the earlier ships. There were then several proposals to build a larger version of *Vittorio Veneto,* but these were shelved in favour of the 'through-deck' carrier, *Giuseppe Garibaldi,* and this ship became the last of its line.

MODERNISATION

Vittorio Veneto was taken in hand from 1981 to early 1984 for modernisation, which included the installation of four Teseo launchers and three twin Breda Compact 40 mm guns. The electronics suite was also modernised.

ALMIRANTE GRAU



Almirante Grau (Ian Sturton)
1 *Twin 152 mm (6 in) 53 guns* **2** *Signaal LIROD 8 optronic directors* **3** *Signaal STIR* **4** *Signaal LW-08 air search radar* **5** *Signaal DA-08 surface search radar* **6** *Signaal WM 25 fire-control director* **7** *Racal-Decca 1226 navigation radar* **8** *Bofors 40 mm/70* **9** *OTOBREDA OTOMAT Mk 2*

GENERAL SPECIFICATIONS

Operator: Peru
Type: Cruiser, gun-armed (CG)

Class: ALMIRANTE GRAU

Purchased: 1
Active: 0

Displacement:
standard: 9,529 t
full load: 12,165 t

Dimensions:
Length: 190.3 m (624.5 ft)
Beam: 17.3 m (56.7 ft)
Draught: 6.7 m (22 ft)

Speed: 32 kts
Range: 7,000 n miles at 12 kts

Complement: 953 (49 officers)

SHIPS

ALMIRANTE GRAU (CLM 81)			
Built as	*De Ruyter* (C-801)	**Launched**	24 Dec 1944
Builder	Wilton-Fijenoord, Schiedam, Netherlands	**Commissioned (RNethN)**	18 Nov 1953
		Transferred to Peru	7 Mar 1973
Laid down	5 Sep 1939	**Commissioned (Peru)**	23 May 1973 (*Almirante Grau* (CLM 81))

WEAPONS SYSTEMS

SURFACE TO SURFACE MISSILES (SSM)

OTOBREDA/Matra Otomat Mk 2 (TG 1)

Eight OTOBREDA Otomat launchers are mounted, in two groups of four, either side of the mainmast. These were removed from frigates. The Mk 2 is specifically designed to receive mid-course guidance from a helicopter to achieve its maximum capability, but as *Almirante Grau* does not carry a helicopter it must be assumed that a helicopter from another ship will be given the task.

Specifications
Length: 4.46 m (14.6 ft)
Diameter: 46 cm (1.51 ft)
Wing span: 1.36 m (4.46 ft)
Weight:
missile, without boosters: 762 kg (1,680 lb)
missile, with boosters: 770 kg (1,698 lb)
warhead: 201 kg (443 lb)
Range: 86 n miles (160 km)
Speed: Mach 0.9
Guidance: Inertial and active radar homing

The Peruvian cruiser Almirante Grau *has the heaviest gun armament of any current warship: eight Bofors 152 mm/53 in four twin turrets. There are also eight Otomat Mk 2 anti-ship missiles, with four mounted on a new platform deck either side of the after mack. The large 'egg' atop the bridge houses the Signaal WM25 fire-control radar, while the DA-08, also from Signaal, is at the head of the foremast mounted on top of a large cabin. Secondary armament is not fitted*
(J L M van der Burg)

Manufacturer/Contractor
OTOBREDA (formerly OTO Melara), Rome, Italy.

GUNS

Bofors 152 mm L/53 medium-calibre dual-purpose guns

With the retirement of the US Navy's battleships the Peruvian cruisers have the heaviest gun armament of any warship afloat. *Almirante Grau* retains four twin turrets, each equipped with two Bofors TAK 152 mm/53 guns. The weapons for the Dutch cruisers were produced in the late 1940s and were based on the TAK 152 L/53 produced in 1942 for the Swedish 'Tre Kronor' class cruisers. The TAK 152 fires semi-fixed ammunition based upon a 46 kg (101 lb) projectile.

Specifications
Calibre: 152 mm (6 in)
Length of barrel: 53 calibres
Muzzle velocity: 900 m/s (2,953 ft/s)
Range: 25,970 m (28,400 yd)
Traverse: 360°
Elevation: −10 to +60°
Shell: 45.8 kg (101 lb)
Cartridge: 32.56 kg (71.8 lb)
Rate of fire: 10 rds/min/barrel

Manufacturer/Contractor
Bofors Ordnance, Sweden.

Bofors 40 mm/70

Eight Bofors 40 mm guns are installed in single mounts, four forward abreast the bridge, and four aft.

Specifications
Traverse: 360° (nominal) at 90°/s
Elevation: −3 to +85° at 60°/s
Rate of fire: 300 rds/min
Muzzle velocity: 1,005-1,025 m/s (3,297-3,363 ft/s)
Max range:
anti-surface: 6.5 n miles (12 km)
anti-air: 2.2 n miles (4,000 m)
Ammunition weight: 2.4 kg (5.29 lb)
Projectile weight: 0.96 kg (2.11 lb)
Crew: 4

DEPTH CHARGES

Two racks.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES (ECM)

DAGAIE countermeasures system

The DAGAIE launcher comprises 6 or 10 munition containers, each of which is loaded with either IR or chaff rockets.

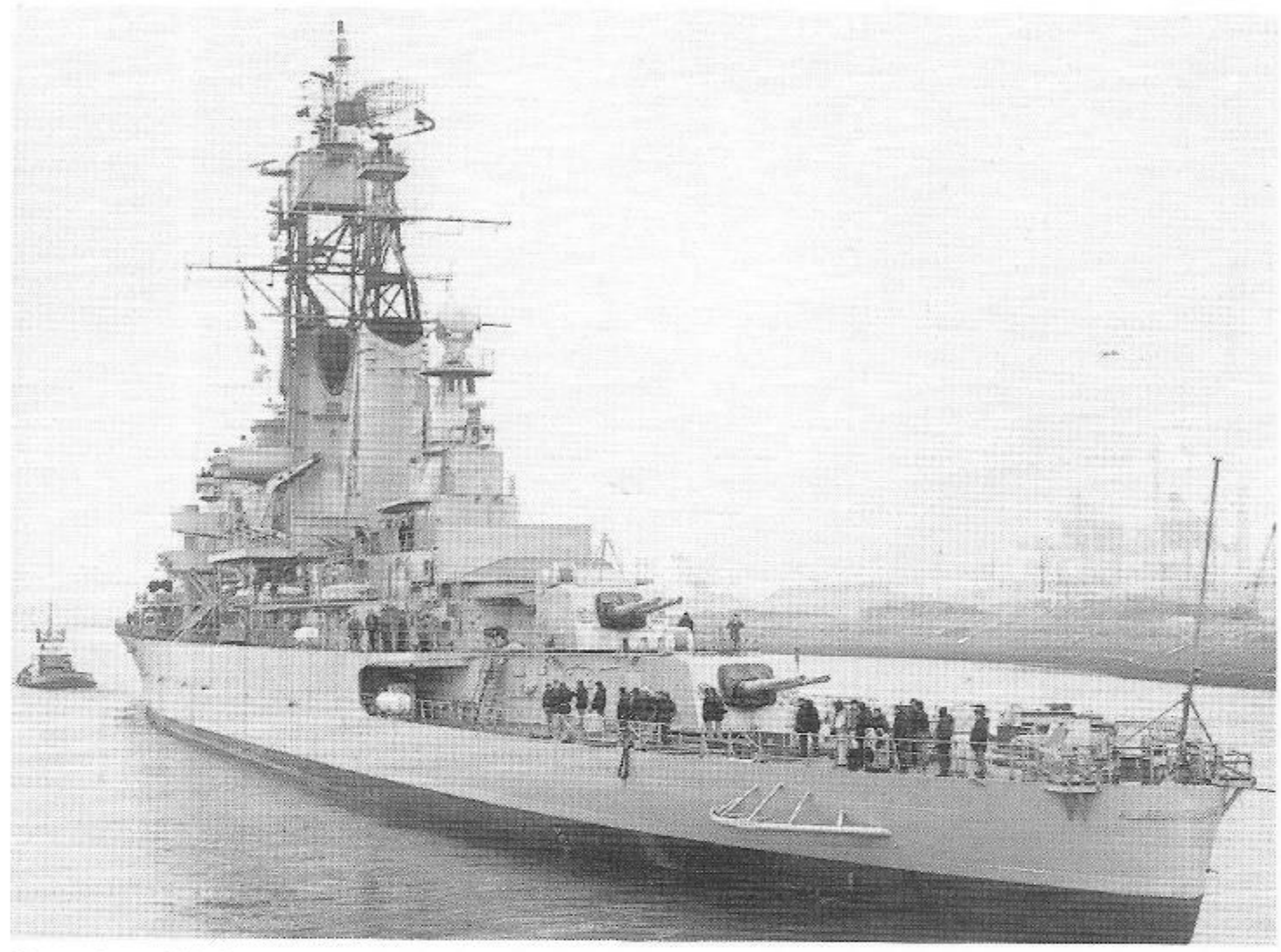
The firing sequence runs automatically and is triggered on a missile alarm from a variety of sources, such as radar, ESM systems, or optical sights, thus providing a very short reaction time. The firing direction is optimised in accordance with the threat bearing, windspeed and direction, ship heading and speed data.

The launching of radar and IR decoys is so arranged that advanced mixed-guidance missile systems cannot discriminate between them and thus collocation of both decoys is achieved. The installation is a double mounting and comprises: (a) two trainable mountings carrying 10 replaceable containers (suitcases), each of which is loaded with either IR or I/J-band chaff projectiles.

A wide range of ammunition by Etienne Lacroix Defénse provides seduction, distraction and seduction/dissimulation modes. The electromagnetic decoys are normally based upon aluminised glass fibre chaff with rapid bloom time and they cover the I and J frequency bands. The infra-red decoys cover both the 3-5 and the 8-14 µm bands.

Specifications
Traverse: 330° at 21°/s
Average reaction time: Within 4 s
REM rocket dimensions: 850 × 127 mm (33.5 × 5 in)
Rocket weight: 13 kg (28.66 lb)
Container dimensions: 900 × 130 mm (35.4 × 5.1 in)
Container weight: 20 kg (44.1 lb)
LIR/LEM container dimensions: 780 × 630 × 134 mm (30 × 24.8 × 5.3 in)
Container weight: 54 kg (119 lb)

Manufacturer/Contractor
CSEE Défense, Paris, France.



Stern view of Almirante Grau *shows the after twin 152 mm turrets, Signaal STIR radar, and Signaal LW-08 air search radar* (J L M van der Burg)

CSEE Sagaie

One CSEE Sagaie 10-barrelled trainable decoy launcher. SAGAIE (*Système d'Autodéfense pour la Guerre Infra-rouge et Electromagnetique*) provides protection against incoming missiles guided by electromagnetic (EM) or infra-red (IR) seekers, or any combination of these two, even when the missiles are attacking simultaneously over the entire horizon. SAGAIE is fully automatic from the reception of a missile threat alarm and optimises the use of decoys in a very short reaction time firing either EM or IR decoy rocket type ammunition.

Specifications
Range:
chaff: 4.3 n miles (8 km)
IR flares: 1.6 n miles (3 km)

Manufacturer/Contractor
CSEE Défense, Courtaboeuf, France.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Signaal SEWACO/Foresee-PE

Dutch electronics company Hollandse Signaalapparaten BV (Signaal) has developed a family of command and weapon control systems known as SEWACO (SEnsor Weapon control And COmmand), although strictly, this designation is only for ships of the Royal Netherlands Navy. The *Almirante Grau* is fitted with one of the export derivatives of this system, designated the Command, Communications, Control and Co-ordination system, usually known as '4C' (Foresee).

At the heart of the SEWACO is the C^2 system, which is designed to present raw and/or processed sensor data from search and fire-control radars together with IFF, sonar, electronic warfare and electro-optic systems to create a picture of the tactical situation. The data may also be used to designate targets to weapon systems and to assist in operations with auxiliary functions such as ASW helicopter direction and tactical navigation.

The Peruvian ship has an SMR-MU micro-mainframe computer for general purpose, real-time, processing. Software is written in RTL-2, with Assembler being used for high-speed data processing. Foresee uses the CIDIS (Combat Information Display System).

Manufacturer/Contractor
Hollandse Signaalapparaten BV, Netherlands.

WEAPONS CONTROL

HSA Lirod 8 optronic directors

There are two LIROD (Lightweight Radar Optronic Director) lightweight fire-control systems based upon a K-band tracking radar and a TV camera. These are designed to provide simultaneous control for two dual-purpose guns, while tracking one air and one surface target and may be used either as stand-alone units or to complement the fire-control systems. The system reaction time from detection to the beginning of the engagement is about 4.5 seconds. The radar has a 0.6 m (2.0 ft) diameter parabolic antenna with monopulse cluster and a very narrow pencil beam, and is resistant to clutter through the application of pulse Doppler tracking combined with FFT techniques. There are also sophisticated ECCM facilities. The radar can track fighter-size targets up to 18 km away and is capable of tracking targets with a maximum speed of 1,000 m/s (3,281 ft/s). In addition to the radar there is a militarised TV camera with CCIR standard video format, which can detect fighter-size targets at about 10 km and large surface ships at about 20 km.

Specifications
Director
Traverse: 360°/s
Elevation: −25 to +150° (−30 to +85°)
Traverse speed: 120°/s
Elevation speed: 80°/s
Radar: K band
Field of view:
TV camera: 3-30° (2-20°)
IR camera: 3°

Laser rangefinder
Pulse length: 20 ns
Max repetition frequency: 10 Hz
Beam divergency: 1.2-1.5 mrad

Laser tracker
Max repetition frequency: 25 Hz
Beam divergency: 1.5 and 6 mrad

Manufacturer/Contractor
Hollandse Signaalapparaten BV, The Netherlands.

SONAR

EDO CWE-610
The EDO hull-mounted CWE-610 low-frequency (LF) sonar was specially designed by EDO for the RNethN and was installed in *Almirante Grau* during its Dutch service. Maximum range is 29,261 m (32,000 yd) and it can handle targets moving at up to 40 knots.

Manufacturer/Contractor
EDO, Government Systems Division, College Point, New York, USA.

RADARS

Set	LW 08	DA 08	Type 1226	WM25	STIR
Company	HSA	HSA	Racal/Decca	HSA	HSA
Role	Air search	Surface search/ target indication	Navigation	Fire control (152 mm guns)	Fire control (40 mm guns)
Band	D	E/F	I	I/J	I/J/K
Range	145 n miles for 2 m² target at 85,000 ft	92 n miles		25 n miles (46 km)	76 n miles (140 km)
Beam	2.2 × csc² to 40°	1.5 × csc² to 40°	1.2°	1.5 × 4.7°	1.4°
Peak power	150 kW	145 kW	25 kW	200 kW	220 kW
Gain	30 dB	33 dB	30 dB	33.5 dB	
Pulsewidth	35/69 µs	35/69 µs	0.05/0.25/1 µs	0.22/0.45 µs	0.29 µs
PRF	1,000/500 pps	1,000/500 pps		3,600/1,800 pps	1,800/3,600 pps
Scan rate	7.5/15 rpm	10/20 rpm	28 rpm	60 rpm	

PROPULSION

Specifications
System: Steam turbines
Boilers: 4 Werkspoor-Yarrow three-drum boilers
Main machinery: 2 De Schelde-Parsons geared steam turbines; 62.5 MW (85,000 shp)
Shafts: 2

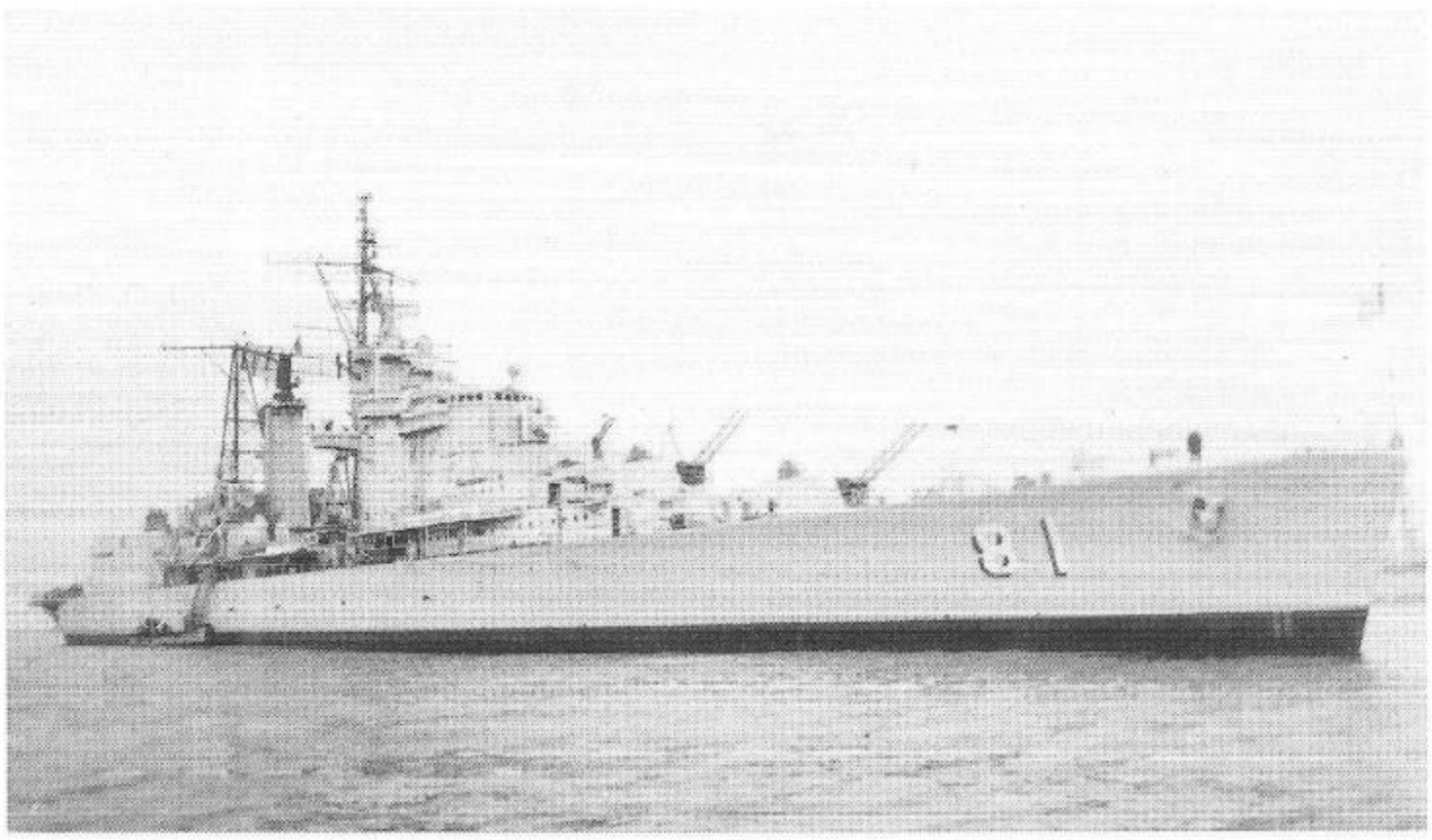
FURTHER INFORMATION

PROGRAMME

The Peruvian *Almirante Grau* is the last of the traditional gun-armed, armoured cruisers to serve in any navy, although it is uncertain whether or not it will return to service. The ship was built for the Royal Netherlands Navy (RNethN) and was one of two 'Provincien' class cruisers authorised in 1938 for service in the Dutch East Indies. Both were laid down in 1939, but the work slowed down during the German occupation. The future *Almirante Grau* was, however, given an 'Atlantic bow' (that is, more raked and with greater flare) as a result of the adverse experiences of the straight-stemmed German battleships and cruisers in the heavy weather of the North Atlantic during the early days of the war.

The design was then recast with British help during 1945-46, principally to incorporate wartime lessons, and construction restarted in 1947. This ship was launched as *De Ruyter* in 1953 and it was planned at one stage that, like *De Zeven Provincien,* it would be converted to operate/Terrier SAMs. The expense proved too great and, in the event, *De Ruyter* was not converted, serving out her time as a gun-armed squadron flagship.

De Ruyter was sold to Peru on 7 March 1973 and commissioned as *Almirante Grau* on 23 May 1973.



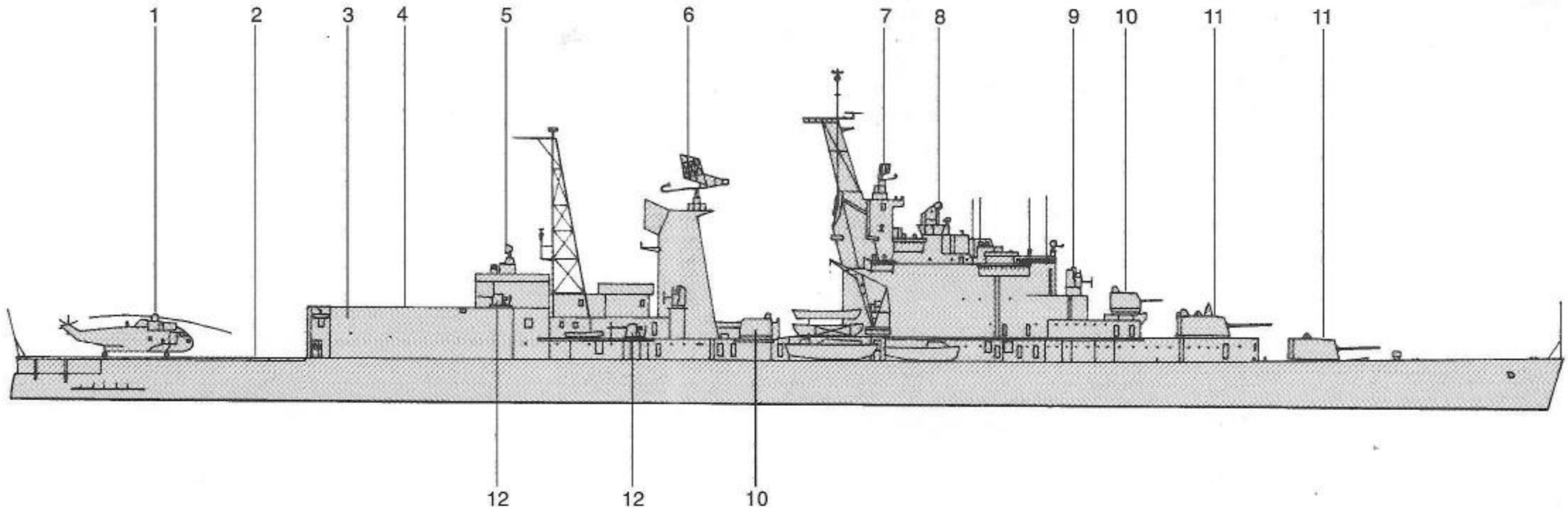
This picture illustrates an unusual Peruvian Navy tradition. The ship clearly has a hangar indicating that it is Aguirre, *the helicopter carrier, but the pennant number (81) is that of the gun-armed* Almirante Grau. *The explanation is that Peruvian law requires that there always be a ship named* Almirante Grau *in the active list, so that when the original* Almirante Grau *(CLM 81) was in refit from 1985 to 1988,* Aguirre *(CH 84) temporarily assumed the other ship's identity, as seen here*

MODERNISATION

Almirante Grau was given a minor refit on transfer in 1973, but in March 1985 it was taken in hand for a two and a half year modernisation by Amsterdam Dry Dock Co. The original plan was that this modernisation would include reconditioning the mechanical and electrical engineering systems, fitting of SSM and SAM, replacement of electronics and installing one CSEE Sagaie and two Dagaie launchers. In 1986, however, financial constraints limited the work, although much had already been done to update sensors and fire-control equipment. The ship sailed for Peru on 23 January 1988 without her secondary gun armament, and with the balance of work to be completed at Sima Yard, Callao, Peru.

The Peruvian Navy is known to have plans to replace the Otomat launchers by Exocet SSM launchers taken from the Peruvian 'Ferre' class destroyers (former British 'Daring' class). It has yet to be confirmed that this has been done.

AGUIRRE



Aguirre (Ian Sturton)
1 *Agusta SH-30D Sea King (three carried)* **2** *Flight deck; 35 × 17 m (115 × 56 ft)* **3** *Hangar* **4** *Secondary flight deck; 20 × 16.5 m (66 × 54 ft)* **5** *Signaal LIROD optronic director* **6** *Signaal LW-02 air search radar* **7** *Signaal DA-02 surface search/target indication radar* **8** *Signaal M25 fire-control director* **9** *Signaal M45 fire-control radar/director* **10** *Bofors twin 57 mm/60* **11** *Bofors twin 152 mm (6 in)/53* **12** *Bofors single 40 mm/70*

GENERAL SPECIFICATIONS

Operator: Peru
Type: Cruiser/helicopter carrier (CH)

Class: AGUIRRE

Purchased: 1
Active: 1

Displacement:
standard: 9,850 t
full load: 12,250 t

Dimensions:
Length: 185.6 m (609 ft)
Beam: 17.3 m (56.7 ft)
Draught: 6.7 m (22 ft)

Armour:
belt: 76-102 mm (3-4 in)
decks: 20-25 mm

Speed: 32 kts
Range: 7,000 n miles at 12 kts

Complement: 953 (49 officers)

SHIPS

AGUIRRE (84)

Builder	Rotterdamse Droogdok Maatschappij, Rotterdam, Netherlands	**Launched**	22 Aug 1950
		Commissioned (RNethN)	17 Dec 1953 (*De Zeven Provincien* (C 802))
		Transferred to Peru	Aug 1976
Laid down	19 May 1939	**Commissioned (Peru)**	31 Oct 1977 (*Aguirre*)

WEAPONS SYSTEMS

GUNS

Bofors 152 mm L/53 medium-calibre dual-purpose guns

Aguirre has two forward turrets, each mounting a pair of Bofors TAK 152 mm/53 guns. The weapons for the Dutch cruisers were produced in the late 1940s and were based on the TAK 152 L/53 produced in 1942 for the Swedish 'Tre Kronor' class cruisers. The TAK 152 fires semi-fixed ammunition based upon a 46 kg (101 lb) projectile.

Specifications
Calibre: 152 mm (6 in)
Length of barrel: 53 calibres
Muzzle velocity: 900 m/s (2,953 ft/s)
Range: 25,970 m (28,400 yd)
Traverse: 360°
Elevation: −10 to +60°
Shell: 45.8 kg (101 lb)
Cartridge: 32.56 kg (71.8 lb)
Rate of fire (per barrel): 15 rds/min

Manufacturer/Contractor
Bofors Ordnance, Sweden.

Bofors 57 mm/60

There are three twin 57 mm turrets, one in B position forward and one on either beam in the waist. The L/60 gun was essentially a scaled-up version of the widely used Bofors 40 mm gun, with a glycol/water-cooled liner and a cylindrical expansion tank alongside the barrel, attached to the recoil spring mounting. The fixed rounds, with 2.6 kg (5.7 lb) projectile, are loaded manually into chain-driven hoists (one for each gun) and carried into the upper mounting. They are then transferred into horizontal distributors attached to the elevating mass and these automatically transfer the rounds into the breech. A flash suppressor is at the front of the barrel. Once used by a number of navies, this Peruvian cruiser is now the last known user.

Specifications
(SAK L/60)
Calibre: 57 mm
Length of barrel: 60 calibres
Muzzle velocity: 900 m/s (2,953 ft/s)
Traverse: 360°
Elevation: −10 to +60°
Weight of shell: 2.6 kg (5.73 lb)
Range: 7.8 n miles (14.5 km)
Rate of fire: 130 rds/min/barrel

Manufacturer/Contractor
Bofors Ordnance, Sweden.

Bofors 40 mm/70

Four Bofors 40 mm guns are installed in single mounts in the waist. Two are either side of the gap between the after stack and the mainmast, and two are either side of the deckhouse atop the hangar.

Specifications
Traverse: 360° (nominal) at 90°/s
Elevation: −3 to +85° at 60°/s
Rate of fire: 300 rds/min
Muzzle velocity: 1005-1025 m/s (3,297-3,363 ft/s)
Max range:
anti-surface: 6.5 n miles (12 km)
anti-air: 2.2 n miles (4,000 m)
Ammunition weight: 2.4 kg (5.29 lb)
Projectile weight: 0.96 kg (2.11 lb)
Crew: 4

DEPTH CHARGES

Two racks.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

HSA Lirod 8 optronic directors

There is one LIROD (Lightweight Radar Optronic Director) lightweight fire-control system based upon a K-band tracking radar and a TV camera, which provides simultaneous control for two dual-purpose guns, while tracking one air and one surface target and may be used either as stand-alone units or to complement the fire-control systems. The system reaction time from detection to the beginning of the engagement is about 4.5 seconds. The radar has a 0.6 m (2.0 ft) diameter parabolic antenna with monopulse cluster and a very narrow pencil beam, and is resistant to clutter through the application of pulse Doppler tracking combined

with FFT techniques. There are also sophisticated ECCM facilities. The radar can track fighter-size targets up to 18 km away and is capable of tracking targets with a maximum speed of 1,000 m/s (3,281 ft/s). In addition to the radar there is a militarised TV camera with CCIR standard video format, which can detect fighter-size targets at about 10 km and large surface ships at about 20 km.

Specifications

Director
Traverse: 360°/s
Elevation: −25 to +150° (−30 to +85°)
Traverse speed: 120°/s
Elevation speed: 80°/s
Radar: K band
Field of view:
TV camera: 3-30° (2-20°)
IR camera: 3°

Laser rangefinder
Pulse length: 20 ns
Max repetition frequency: 10 Hz
Beam divergency: 1.2-1.5 mrad

Laser tracker
Max repetition frequency: 25 Hz
Beam divergency: 1.5 and 6 mrad

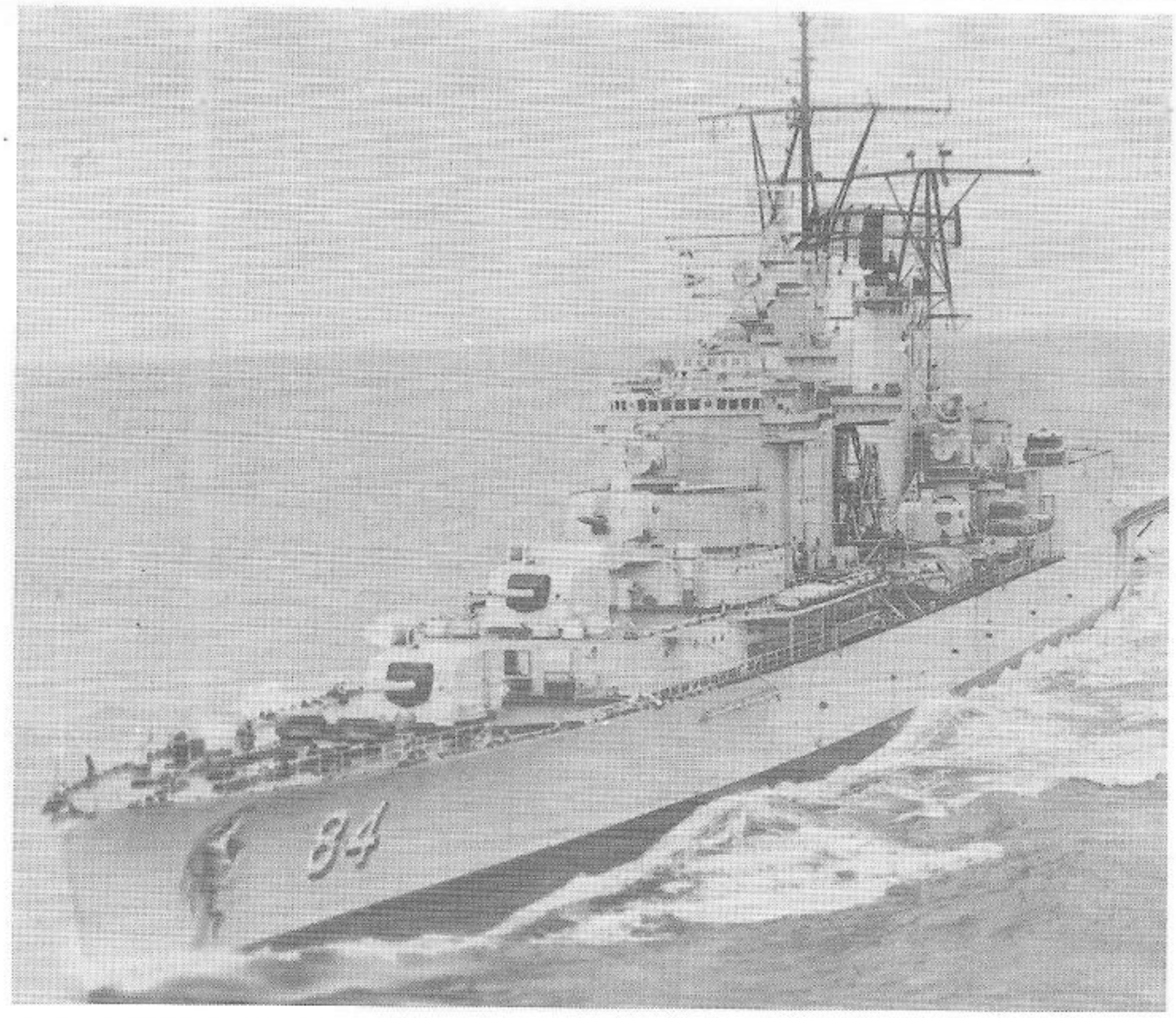
Manufacturer/Contractor

Hollandse Signaalapparaten BV, Netherlands.

SONAR

EDO CWE-10N

This EDO-designed hull-mounted sonar was built by van der Heem in the Netherlands for the RNethN and was installed in *Aguirre* during its Netherlands service. Operating frequency is 10.5 or 11 kHz and maximum range is 32,000 yd; it can handle targets moving at up to 40 knots.



Aguirre *in 1994 showing the large hangar, the mainmast moved aft clear of the mack, and the Signaal LW-02 array atop the after mack*

Manufacturers/Contractors

EDO, Government Systems Division, College Point, New York, USA.
van der Heem, Netherlands.

RADARS

Set	LW 02	DA 02	ZW 03	M 45	M 25
Company	Signaal	Signaal	Signaal	Signaal	Signaal
Role	Air search	Surface search/target indication	Navigation	Fire control	Fire control
Band	D	E/F	I/J	I/J	I/J
Beam	2.2 × csc²	1.7 × csc²	1.0 × 3.5°	—	1.5 × 4.7°
Peak power	500 kW	500 kW	180 kW	180 kW	200 kW
Gain	31 dB	32 dB	39 dB	33.5 dB	33.5 dB
Pulsewidth	2/5 µs	1.3/0.5 µs	0.1/0.3 µs	—	0.22/0.45 µs
PRF	500/250 pps	500/1,000 pps	2,000/1,000 pps	—	3,600/1,800 pps
Scan rate	1-10 rpm	6-60 rpm	7.5/15 rpm	—	60 rpm
Range	'aircraft' at 100 n miles, 59,000 ft	40 n miles at 30,000 ft against 2 m² target	Minor craft at 18 n miles	—	—

AVIATION

AVIATION FACILITIES

Specifications

Main flight deck:
length: 35 m (115 ft)
width: 17 m (56 ft)
Hangar roof helicopter platform:
length: 20 m (66 ft) (approx)
width: 16.46 m (54 ft) (approx)

HELICOPTERS

Three Agusta ASH-3D Sea Kings armed with AM 39 Exocet missiles.

Agusta-Sikorsky AS-61 (SH-3D)

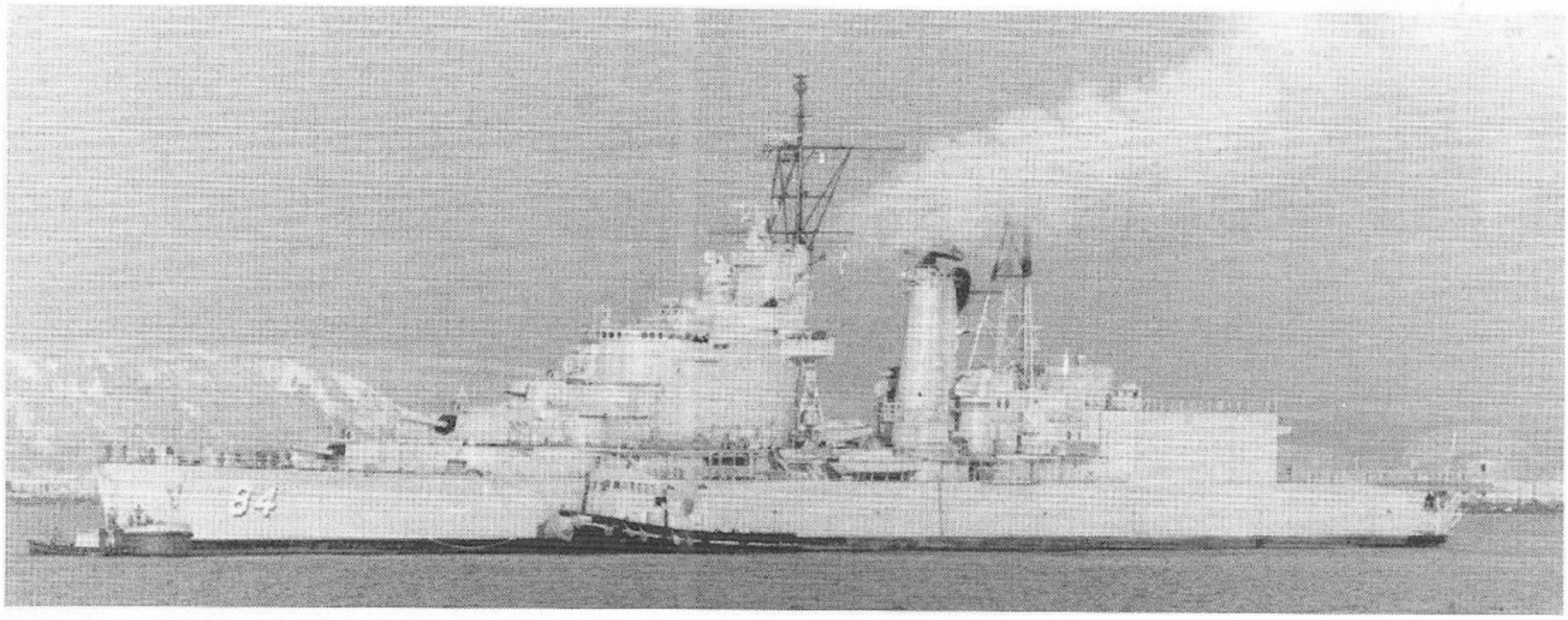
Aguirre normally embarks three Agusta-Sikorsky SH-3D helicopters armed with AM 39 Exocet anti-ship missiles.

Specifications

Main rotor diameter: 18.90 m (62.0 ft)
Length overall (both rotors turning): 21.91 m (71.89 ft)
Height to rotor head: 4.74 m (15.5 ft)
Rotor disc area: 280.5 m² (3,019 sq ft)
Max take-off weight: 9,525 kg (21,000 lb)
Max speed (never exceed): 144 kts (267 km/h)
Typical cruising speed: 120 kts (222 km/h)
Service ceiling: 3,720 m (12,200 ft)
Range with max standard fuel: 630 n miles (1,166 km)
Engines: 2—1,118 kW (1,500 shp) General Electric T58-GE-100 turboshafts
Role equipment: Underwing pylons (6), torpedo bay, sonobuoy ports (32), depth-charge racks (2), search radar, FLIR, MAD
Accommodation: 4 (pilot, co-pilot, two sonar operators)
Sensors: Low-frequency 360° AQS-18/AQS-13F sonar; Doppler radar; SMA/APS-707 radar (chin radome)
Weapons: 2 Exocet AM 39 anti-ship missiles

Specifications

(Exocet AM 39)
Length: 4.68 m (15.33 ft)
Wing span: 1.004 m (39.4 in)
Diameter: 0.35 m (13.8 in)
Weight:
missile: 650 kg (1,433 lb)
warhead: 165 kg (364 lb)
Range: 32-47 n miles (52-75 km)
Speed: Mach 1



Aguirre *(formerly* De Zeven Provincien). *The tall stacks and high bridge are still evident but the entire after end has been restructured to create a large flight deck and a hangar capable of accommodating three SH-3 Sea Kings* (UK MoD/HMS Excellent)

PROPULSION

Specifications
System: Steam turbines
Boilers: 4 Werkspoor-Yarrow boilers

Main machinery: 2 De Schelde-Parsons turbines; 62.2 MW (85,000 shp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

A sister ship to *Almirante Grau, Aguirre* was laid down in 1939 as *De Zeven Provincien.* Little work was done on either ship during the German occupation of the Netherlands, apart from giving *De Zeven Provincien* an 'Atlantic bow' with greater rake, following the adverse experiences of the straight-stemmed German battleships and cruisers in the heavy seas of the North Atlantic during the early days of the war. The design was entirely recast in 1945-46 to take account of the lessons of the war and work restarted in 1947, with both ships being completed in 1953. Both ships spent their service with the RNethN as squadron flagships (a role later taken over by the 'Tromp' class destroyers). Unlike her sister ship, however, *De Zeven Provincien* was converted to a guided-missile cruiser, armed with US-supplied Terrier missiles in 1962-64.

After 23 years service in the Dutch Navy *De Zeven Provincien* was bought by Peru in August 1976 and returned to the original builders for conversion and for the removal of the entire Terrier installation, which had to be returned to the United States. The ship was converted to a helicopter cruiser, the work being completed on 31 October 1977, producing a ship which resembled the contemporary British 'Tiger' class. Three Agusta ASH-3D Sea Kings are carried and there are two landing spots; one on the flight deck the second on the hangar roof. *Aguirre* was placed in reserve in 1992/93 with only a caretaker crew, but returned to the operational fleet in 1994.

RENAMING

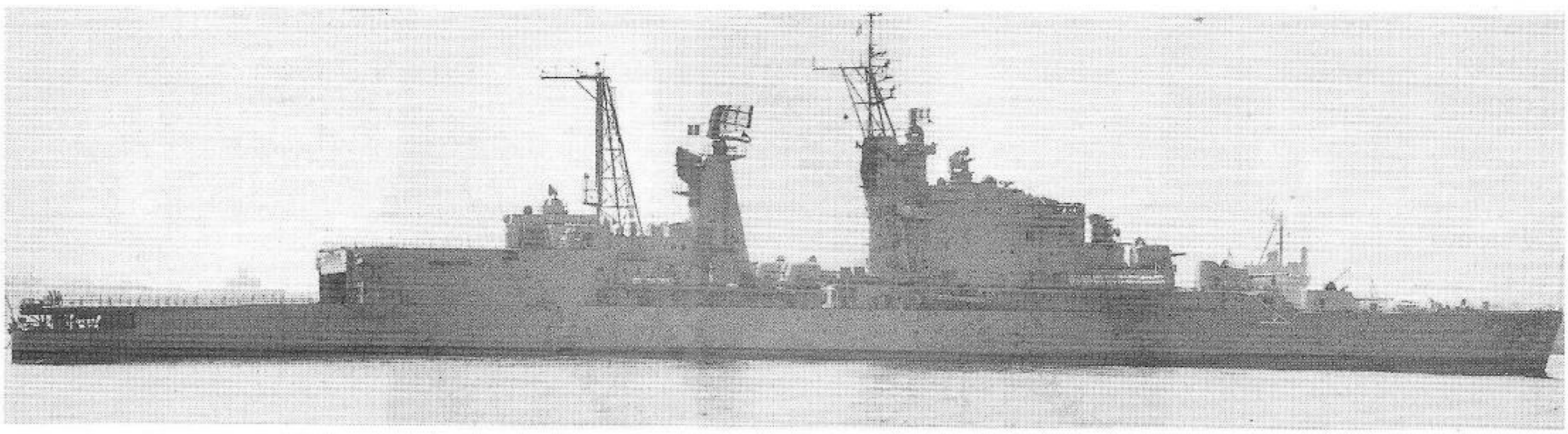
It is a legal requirement that there must always be a ship named *Almirante Grau* in commission in the Peruvian Navy. As a consequence, during the period that CLM 81 was in refit in Amsterdam in 1986/87, the other ship, *Aguirre,* assumed the name *Almirante Grau,* while the former *Almirante Grau* became *Proyecto 01.* The two ships resumed their former names as soon as the original *Almirante Grau* started its post-refit sea trials in November 1987.

MODERNISATION

Aguirre underwent a major refit, including retubing the boilers in 1985/86.

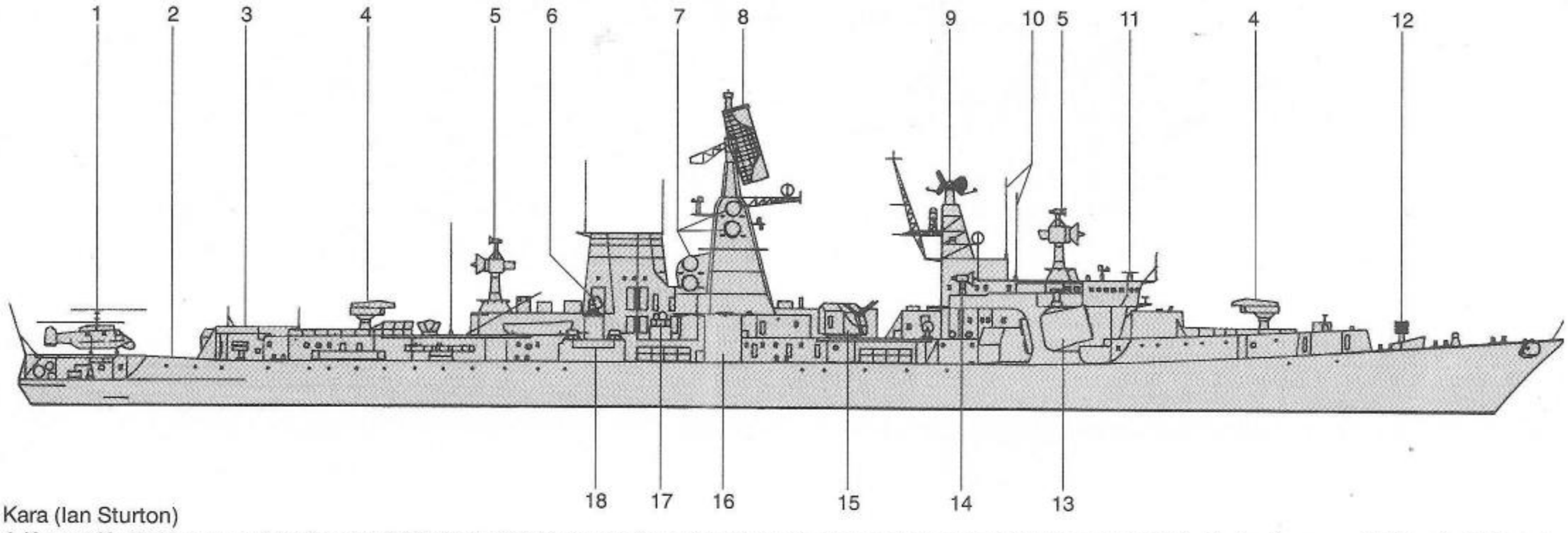
OPERATIONAL

The ship was temporarily in reserve in 1992-93, but returned to operational status in 1994.



Aguirre *in June 1994* (Peruvian Navy)

KARA (TYPE 1134)



Kara (Ian Sturton)

1 *Kamov Ka-25 Hormone-A helicopter* **2** *Flight deck* **3** *Hangar* **4** *SA-N-3 twin arm launcher* **5** *Head Light* **6** *Bass Tilt* **7** *Side Globe (jammers)* **8** *Top Sail 3D radar* **9** *Head Net C* **10** *HF rod antennas* **11** *Don Kay/Palm Frond navigation* **12** *RBU 6000* **13** *SS-N-4 anti-ship missile* **14** *Owl Screech* **15** *Twin 76 mm/60 gun* **16** *SA-N-4 missile launcher* **17** *Pop Group* **18** *30 mm Gatling CIWS*

GENERAL SPECIFICATIONS

Operator: Russia
Type: (all less *Azov* — Type 1134B; *Azov* — Type 1134BF
Russian designation: *bolshoy protivolodochny korabl;* large anti-submarine ship

Class: KARA (BERKOT-B)

Built: 7
Active: 5

Displacement:
standard: 8,000 t
full load: 9,900 t

Dimensions:
Length: 173.2 m (568 ft)
Beam: 18.6 m (61 ft)
Draught: 6.7 m (22 ft)

Speed: 34 kts
Range: 9,000 n miles at 15 kts cruising turbines; 3,000 n miles at 32 kts

Complement: 540 (30 officers)

SHIPS

OCHAKOV

Builder	Nikolayev North (61 Kommuna), St Petersburg, Russia
Laid down	Mar 1970
Launched	Jun 1971
Commissioned	7 Nov 1973

KERCH

Builder	Nikolayev North (61 Kommuna), St Petersburg, Russia
Laid down	Jun 1971
Launched	Jul 1972
Commissioned	Sep 1974

AZOV

Builder	Nikolayev North (61 Kommuna), St Petersburg, Russia
Laid down	Aug 1972
Launched	Sep 1973
Commissioned	Nov 1975

PETROPAVLOVSK

Builder	Nikolayev North (61 Kommuna), St Petersburg, Russia
Laid down	Nov 1973
Launched	29 Nov 1974
Commissioned	5 Feb 1976

VLADIVOSTOK (ex-Tallinn)

Builder	Nikolayev North (61 Kommuna), St Petersburg, Russia
Laid down	Dec 1975
Launched	6 Nov 1976
Commissioned	Apr 1978

WEAPONS SYSTEMS

TABLE I: WEAPON SUMMARY

Weapon type	Designation	All except *Azov*	*Azov*
Surface-to-air missile launchers	SA-N-3 (twin launcher)	2	1
	SA-N-6 (vertical launchers)	—	6
	SA-N-4 (twin launcher)	2	2
Guns	76 mm/60, twin	2	2
	30 mm/65	4	4
Torpedo tubes	533 mm (21 in)	2 × 5	2 × 2
ASW mortars	RBU 6000	2	2
	RBU 1000 (not in *Petropavlovsk)*	2	2
Helicopters	Ka-27 Helix A	1	1

SURFACE-TO-AIR MISSILES (SAM)

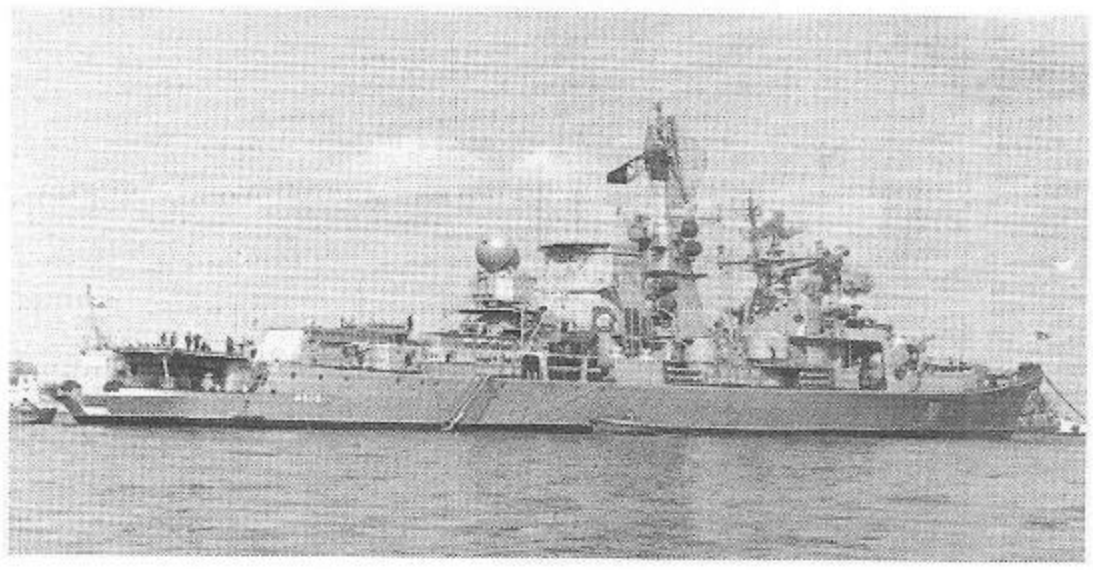
SA-N-3 'Goblet'

The SA-N-3 is the primary air defence system, all ships except *Azov* having two launchers (one forward, one aft), while *Azov* has only one. The missile (Russia = 4K60/4K65; NATO = SA-N-3 'Goblet') is of conventional design, with a semi-active radar seeker and a guidance system with a UHF uplink/downlink to the launching ship. There are two versions of the missile, of which the 'Kara' class carries the shorter-range version (NATO = SA-N-3A). The launcher is unstabilised and has two launch rails which are reloaded from their own magazine, each of which contains 18 rounds, giving a total of 36 missiles in *Azov* and 72 in the remainder.

The target is acquired by the 'Top Sail' 3D radar and then designated by the 'Head Light' fire-control radar, one per launcher. Each 'Head Light' has four circular parabolic antennas and a smaller fifth one which may be either for IFF or the command link with the missile; the two upper antennas can move separately from the lower pair. The radar illuminates the target and probably tracks the missile to ensure it is on target, possibly updating commands through the fifth antenna. Two missiles may be guided onto a single target simultaneously by each 'Head Light'.

Specifications

Length: 6.1 m (20 ft)
Diameter: 60 cm (23.6 in)
Wing span: 1.4 m (4.59 ft)
Weight: 845 kg (1,863 lb)
Warhead: 80 kg (176 lb) HE (fragmentation)
Fuzes: Impact/proximity
Speed: Mach 2.5
Range: 1.5-16 n miles (3-30 km)



Two views of Azov, *a 'Kara' class cruiser but armed with SA-N-6 instead of the after SA-N-3 launcher and a different sensor fit. The single SA-N-3 launcher is on the foredeck, but the after launcher has been replaced by six SA-N-6 vertical launchers, each with four missiles. In addition, the after Head Light missile control radar has been replaced by a Top Dome director* (H & L van Ginderen Collection)

Altitude: 100-25,000 m (328-82,000 ft)
Guidance: Radar command with semi-active homing

Manufacturer/Contractor
Fakel, Russia.

SA-N-6 'Grumble' (Fort/ Rif) area defence system
Azov was built as the trials ship for the SA-N-6 'Grumble' (Rif) vertical launch system, with six vertical launchers. This air defence system is designed to operate in a hostile environment and is intended to counter multiple attacks by missile-carrying aircraft and by anti-ship missiles launched by both surface ships and submarines. The S-300PMU missile is powered by a combined booster-sustainer using solid propellant, with an HE fragmentation or optional nuclear warhead, and an active radar seeker. Command and control is via the Top Dome system.

Specifications
Length: 7.11 m (23.33 ft)
Diameter: 45 cm (17.7 in)
Wing span: 0.9 m (35.43 in)
Weight: 1,500 kg (3,307 lb)
Speed: Mach 3
Max range: 48.5 n miles (90 km)
Max altitude: 27,432 m (90,000 ft)
Warhead: 90 kg (198 lb) (or nuclear?)
Guidance: Command and inertial with semi-active radar track-via-missile

Manufacturers/Contractors
Altair Research and Development Corporation, Russia (system).
Fakel, Russia (missile).

SA-N-4 short-range missile system
There are two SA-N-4 launchers in the waist, either side of the mainmast. The twin-rail launcher lies beneath a hinged flat cover plate, emerging to launch its missiles and retracting to reload. This is likely to result in a low rate of fire which must be slowed even further by the need to close the magazine cover before firing. Below the launcher are four revolving drums each with five missiles while the electromechanical and hydraulic machinery is below that.

On launch, the booster burns for 2 seconds allowing the radar to gather the missile at a range of 0.75 n miles (1.5 km), following which the sustainer burns for 15 seconds. Command and control is via the Pop Group system (see below)

Specifications
Length: 3.1 m (10.17 ft)
Diameter: 21 cm (8.27 in)
Wing span: 64 cm (25.2 in)
Weight: 130 kg (286.6 lb)
Speed: Mach 2.5
Warhead: 50 kg (110 lb) HE
Range: 0.75-8 n miles (1.5-15 km)
Height: 9-3,000 m (30-10,000 ft)
Guidance: Semi-active radar homing

TUBES

There are two quintuple 533 mm (21 in) torpedo tubes in all ships in the class, except for *Azov,* which has only two twin tubes. In all cases the tubes are used to launch the usual combination of Russian 533 mm (21 in) torpedoes.

TORPEDOES

SS-N-14 'Silex' long-range anti-submarine torpedo delivery system
Eight SS-N-14 ('Silex') missiles are carried in two large quad launchers mounted either side of the bridge. SS-N-14 is a long-range torpedo delivery system capable of operating to beyond the First Convergence Zone. The missile is powered by a solid propellant booster-sustainer and is reported to have an autopilot which can be updated in flight. Payload is a torpedo which is faired into the underside of the airframe. The ASW version of the weapon requires only 15 seconds warm-up time and cruises at a height of some 750 m (2,461 ft), being guided towards the approximate location of the target by radio command. When the torpedo is ejected it deploys its parachute which slows the descent. On entering the water the parachute is disconnected and the weapon begins a search pattern to acquire the target.

Specifications
SS-N-14
Length: 7.2 m (23.62 ft)
Diameter: 0.574 m (1.88 ft) (1.35 m (4,43 ft) with torpedo)
Launch weight: 4,000 kg (8,818 lb)
Range:
anti-submarine: 30 n miles (55 km)
anti-ship: 19 n miles (35 km)
Speed: Mach 0.95
Guidance: Autopilot and command update

Type E53 torpedo
Performance: Active/passive homing to 8.1 n miles (15 km) at 40 kts
Warheads:
anti-submarine: 150 kg (330 lb) HE; or 5 kT nuclear
anti-ship: 500 kg (1,102 lb) HE
Propulsion: Electrical

GUNS

AK-726 76.2 mm (3 in)/60 dual-purpose guns
There are two twin AK-726 multirole guns designed for air defence, surface engagement and shore bombardment roles. The turret is protected by a metal shield and houses a five-man crew: a gun captain, two layers and two loaders. Each gun has its own loading system based upon a continuous supply of ammunition from an intermediate magazine on a below-decks platform under the turret. The whole mounting can contain 60 rounds of which two are on the feeder rail and four are on the hoists at any one time. The hoists are hydraulically driven but may be manually operated in the event of power failure. The AK-726 uses the conical scan fire-control radar designated 'Owl Screech'.

Specifications
Calibre: 76.2 mm (3 in)
Length of barrel: 59 calibres
Muzzle velocity: 980 m/s (3,215 ft/s)
Traverse: 360° at 36°/s
Elevation: −7 to +85° at 32°/s
Shell weight: 6.8 kg (15 lb)
Rate of fire: 90 rds/min (complete mount)
Range:
anti-surface: 8 n miles (15 km)
anti-air (max): 10,000 m (32,800 ft); effective 7,000 m (22,970 ft)

30 mm AK-630 close in weapon system
There are four AK-630 close in weapon system (CIWS) turrets, which, instead of being split fore and aft as is the case in most Russian surface warships, are grouped in two pairs either side of the stack. This multi-barrel, high volume-of-fire gun system, has a separate fire-control radar and a below-deck control station with remote optical and/or electro-optical sensor. It fires five types of fire mission: against anti-ship missiles, aircraft, small surface vessels, drifting mines, and unprotected shore targets. The weapon consists of six water-cooled barrels, using the Gatling principle with a fixed breech block and revolving barrels. The magazine contains 2,000 rounds of HE-I and HE-T ammunition. The gun fires bursts of up to 400 rounds, during which both the barrel and the breech block are cooled, with used cartridges and links being ejected into a bin below the elevating mass. The mounting is unusual in having an ignition system for burning off gun gases accumulating within it during firing.

Specifications
Calibre: 30 mm
Length of barrel: 65 calibres
Muzzle velocity: 890 m/s (2,920 ft/s)
Traverse: 360° (depending on location of turret) at 70°/s
Elevation: −12 to +88° at 50°/s
Crew: 1 (off mount)
Range:
radar fire control: 4,000 m (13,124 ft)
electro-optic fire control: 5,000 m (16,405 ft)
Rate of fire: 4,000-5,000 rds/min
Ammunition:
round: 1.224 kg (2.7 lb)
projectile weight: UOF-84 384 g; UOR-84 388 g

ANTI-SUBMARINE MORTARS

RBU-6000
All ships in the class have two RBU-6000 (Smerch) launchers in the bows, which have a similar steel base to the RBU-1000 but with 12 rocket launcher tubes arranged in a circle. The mounting can traverse through 360° and elevation limits are −15 to +60°. Loading is automatic from a below-deck magazine. It is estimated that the rockets weigh 110 kg (242.5 lb), with a 25 kg (55 lb) warhead. Pairs of tubes are fired in sequence. The RGB-60 rocket is fitted with an impact-time fuze, which detonates either on hitting a solid object (such as a submarine) or reaches a preset depth. Firing is usually conducted in a full salvo of 12 rockets, but it is also possible to fire single rockets, or four- or eight-rocket salvos, if the tactical situation requires it. The warhead weighs 31 kg (68.3 lb).

RBU 1000
All ships except *Petropavlovsk* have two RBU-1000 launchers mounted aft, abreast of the hangar. This mounting has two vertical rows of three tubes on each side of a pedestal, with automatic reloading from the below-deck magazine. The tubes are raised to the vertical and the loading mechanism inserts the 90 kg (198.4 lb) rockets in sequence. Range is 1,000 m (3,281 ft) and the warhead contains 55 kg (121.3 lb) HE.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Intercept
Four Rum Tub (fitted on main mast in *Kerch* only).

ELECTRONIC COUNTERMEASURES (ECM)

Side Globe
Eight jammers.

Bell series
Two Bell Slam.
One Bell Clout.
Two Bell Tap (in *Ochakov* only).

DECOYS

Two twin chaff launchers.
One BAT-1 torpedo decoy.

Nikolayev *with two twin SA-N-3 launchers (forward launcher is in the horizontal position; after launcher is vertical), four SS-N-14 launchers either side of the bridge and two twin 76 mm (3 in) gun mounts in the waist. Note the large size of the Top Sail array atop the mast and the two Head Light fire-control radars (for SA-N-3 and SS-N-14) one on the bridge roof, the other aft of the large, square stack* (H & L van Ginderen Collection)

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Two Tee Plinth *(Azov).*
Four Tilt Pot optronic directors.

RADARS

Sensors		All except *Azov*	*Azov*
Radars	Air/surface search Navigation	Flat Screen (*Kerch* only) Head Net C 2 × Don Kay Don 2	Head Net C 2 × Don Kay
Fire control	SA-N-3/SS-N-14 SA-N-4 SA-N-6 76 mm guns 30 mm Gatling	2 × Head Light C 2 × Pop Group — 2 × Owl Screech 2 × Bass Tilt	1 × Head Light C 2 × Pop Group Top Dome 2 × Owl Screech 2 × Bass Tilt
Sonars	Hull-mounted Variable depth	Bull Nose Mare Tail	Bull Nose Mare Tail
Tacan		Fly Spike (in some) Fly Screen A 2 × Round House (*Petropavlovsk* only)	Fly Screen A
IFF		High Pole A High Pole B	High Pole A High Pole B

AVIATION

HELICOPTERS

The 'Kara' class has a relatively small helicopter flight deck aft for a single Ka-27PL (Helix A) ASW helicopter.

Kamov Ka-27PL* (NATO = Helix A)

Specifications
Rotor diameter: 15.90 m (52.16 ft)
Rotor disc area: 397 m² (4,275 sq ft)
Fuselage length: 11.30 m (37.07 ft)
Height to rotor head: 5.40 m (17.72 ft)
Operating weight, empty: 6,500 kg (14,330 lb)
Max take-off weight: 12,600 kg (27,778 lb)
Max payload: 5,000 kg (11,023 lb)
Max level speed at optimum altitude: 135 kts (250 km/h)
Endurance: 4.5 h
Engines: 2 Klimov (Isotov) TV3-117V turboshafts, each 1,645 kW (2,205 shp)
Accommodation: 3 (pilot plus 2)
Sensors: Surface search radar, sonobuoys, dipping sonar
Weapons: Torpedoes (3), nuclear or conventional depth bombs or mines

Note
*PL = *protivolodochny* = submarine

PROPULSION

Specifications
System: Combined gas and gas (COGAG)
Main machinery: 4 boost gas turbines; 80 MW (108,800 hp(m)); 2 cruise gas turbines; 10 MW (13,600 hp(m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The first major class of post-war Russian cruisers was the 15-strong 'Sverdlov' class, constructed between 1949 and 1945. Next to be built was the four-strong 'Kynda' class, which were appreciably smaller and introduced missiles for the first time. Next came fourteen 'Kresta' class, divided into four Kresta Is and 10 Kresta IIs, which were optimised for the ASW mission. These were followed, in turn, by the 'Kara' class,

All ships in the class were built between 1968 and 1979 at the Nikolaev Yard in St Petersburg.

Kerch *was the first in the class to be fitted with the Flat Screen air search radar, which is approximately 7 m (23 ft) high and 6 m (19.7 ft) wide. The narrower antenna along the top is an IFF interrogator. Below the Flat Screen are two Side Globe broadband jammers and under the lower of the two and at each corner of the tower are four Rum Tub arrays, which may also be jammers* (H & L van Ginderen Collection)

DESIGN

The 'Kara' class design is generally similar to that of the Kresta II, but is longer and powered by gas rather than steam turbines. The two SA-N-3 launchers are mounted fore and aft, with their associated Head Lights fire-control systems being one of the dominant features of the ship. The large mainmast supports the very large Top Sail radar. As in the Kresta II there are four SS-N-15 launchers either side of the bridge.

Azov is of a modified design as the SA-N-6 trials ship and emerged from the Black Sea only in June 1986. All are fitted with stabilisers. *Petropavlovsk* has a higher hangar with two Round House Tacan on each side. The helicopter is raised to flight deck level by a lift in all of the class.

The 'Kresta' class main gun armament consists of two twin 57 mm, but in the 'Kara' class this has been increased to two twin main 76.2 mm guns. As in the earlier ships, however, these are sited in the waist and have an arc of fire of some 150° on the beam. Similarly, the 30 mm CIWS turrets are sited in two pairs either side of the stack covering their respective beams, but unable to cover the forward or after arcs.

The hangar arrangements are unusual. The helicopter is pulled forward from the flight deck into the upper hangar, the roof of which is hinged at the forward end and must be raised to allow the aircraft to enter. The helicopter is positioned on an elevator platform and is then lowered into the hangar proper. *Petropavlovsk,* while similar to the other ships of the class (except *Azov)* in other respects has a different hangar arrangement. In this ship the hangar roof is higher and is flanked by two Round House Tacan, which replace the RBU-1000 in this ship.

Azov was the trials ship for the SA-N-6 missile system, which replaces the after SA-N-3 installation. The associated Top Dome radome replaces the Head Light on the after deckhouse roof.

Kerch entered refit in the late 1980s, which included the installation of a Flat Screen radar, in place of the Top Sail. This would have been installed in other ships of the class during their refits, but, in the event, *Kerch* remains the only one.

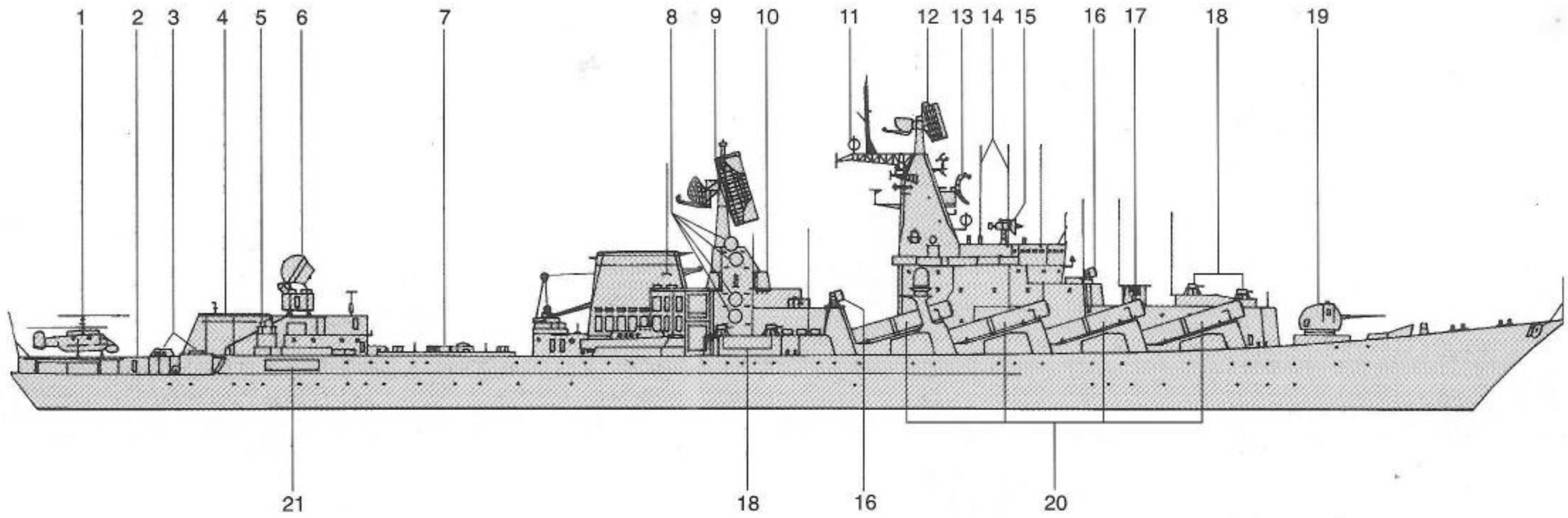
MODERNISATION

The Flat Screen air search radar, first seen in *Kerch,* was to have been retrofitted in all of the class but it appears that this has been cancelled.

OPERATIONAL

Nikolayev and *Tashkent* started refits in July 1987, but were stricken in 1992 and have been scrapped. The oldest of the remaining five ships, *Ochakov,* is in refit but a fire aboard in 1993 may well have prejudiced its chances of going to sea again. *Petropavlovsk* and *Vladivostok* are based in the Pacific Fleet and may have been scrapped in 1996. *Kerch* serves in the Black Sea and *Azov* in the Baltic, but it seems unlikely that either will be retained in service for much longer.

SLAVA (TYPE 1164)



Slava (Ian Sturton)
1 *Kamov Ka-27 Helix* **2** *Flight deck* **3** *SA-N-4 launchers* **4** *Hangar* **5** *Pop Group* **6** *Top Dome* **7** *SA-N-6 vertical launchers* **8** *Side Globe jammers* **9** *Top Pair (Top Sail plus Big Net)* **10** *Rum Tub (four arrays at foot of tower)* **11** *Quad Loop (DF)* **12** *Top Steer* **13** *Front Door* **14** *HF rod antennas* **15** *Kite Screech* **16** *Bass Tilt* **17** *RBU 6000* **18** *30 mm Gatling CIWS* **19** *Twin 130 mm/70 gun* **20** *SS-N-12 launchers* **21** *Five 533 mm (21 in) torpedo tubes*

GENERAL SPECIFICATIONS

Operator: Russia
Type: *raketniy kreyser (RKR)*

Class: SLAVA (ATLANT) (Type 1164)

Built: 4
Active: 4

Displacement:
standard: 9,800 t
full load: 11,200 t

Dimensions:
Length: 186 m (610.2 ft)
Beam: 20.8 m (68.2 ft)
Daught: 7.6 m (24.9 ft)

Speed: 32 kt
Range: 2,500 n miles at 30 kts; 6,000 n miles at 15 kts

Complement: 454 (38 officers)

SHIPS

MOSKVA (formerly Slava)
Builder Nikolayev North (61 Kommuna) St Petersburg, Russia
Laid down 1976
Launched Jul 1979
Commissioned 30 Jan 1983

MARSHAL USTINOV
Builder Nikolayev North (61 Kommuna) St Petersburg, Russia
Laid down 1978
Launched Sep 1982
Commissioned 21 Sep 1986

VARYAG (formerly Chervona Ukraina)
Builder Nikolayev North (61 Kommuna) St Petersburg, Russia
Laid down 1979
Launched Jul 1983
Commissioned 16 Oct 1989

ADMIRAL LOBOV (formerly Ukraina)
Builder Nikolayev North (61 Kommuna) St Petersburg, Russia
Laid down 1984
Launched 15 Aug 1990
Commissioned July 1996

WEAPONS SYSTEMS

The weapon fit is identical between ships, as summarised below:

WEAPON SUMMARY

Weapon type	Designation	'Slava' class
Surface-to-surface missile launchers	SS-N-12	16
Surface-to-air missile launchers	SA-N-6 SA-N-4	8 VLS 2
Guns	130 mm/70 30 mm/65	1 × 2 6
Torpedo tubes	533 mm (21 in)	2 × 5
ASW mortars	RBU 6000	2
Helicopters	Ka-27 Helix A	1

SURFACE-TO-AIR MISSILES (SAM)

SA-N-6 (NATO = Grumble) (Russia = Fort/ Rif) area defence system

Eight SA-N-6 vertical launchers are mounted between the stacks and the after deckhouse. This air defence system is designed to operate in a hostile environment and is intended to counter multiple attacks by missile-carrying aircraft and by anti-ship missiles launched by both surface ships and submarines. The S-300PMU missile is powered by a combined booster-sustainer using solid propellant, with an HE fragmentation or optional nuclear warhead, and an active radar seeker. The 'Slava' class carry eight, eight-round carousels, each with its own loading/launching hatch. Command and control is via the Top Dome system (see below).

Specifications
Length: 7.11 m (23.32 ft)
Diameter: 45 cm (1.48 ft)
Wing span: 90 cm (2.95 ft)
Weight: 1,500 kg (3,309 lb)
Speed: Mach 3
Max range: 48.5 n miles (90 km)
Max altitude: 27,432 m (90,000 ft)
Warhead: 90 kg (198 lb) (or nuclear?)
Guidance: Command and inertial with semi-active radar track-via-missile

Manufacturers/Contractors
Altair Research and Development Corporation, Russia (system).
Fakel, Russia (missile).

SA-N-4 short-range missile system

There are two SA-N-4 launchers aft, abreast of the helicopter hangar, with the twin-rail launcher lying beneath a hinged flat cover plate; it emerges to launch its missiles and retracts to reload. This is likely to result in a low rate of fire which must be slowed even further by the need to close the magazine cover before firing. Below the launcher are four revolving drums each with five missiles while the electromechanical and hydraulic machinery is below that.

On launch, the booster burns for 2 seconds allowing the radar to gather the missile at a range of 0.75 n miles (1.5 km), following which the sustainer burns for 15 seconds.

Command and control is via the Pop Group system (see p.476)

Specifications
Length: 3.1 m (10.17 ft)
Diameter: 21 cm (8.26 in)
Wing span: 64 cm (25.2 in)
Weight: 130 kg (286 lb)
Speed: Mach 2.5
Warhead: 50 kg (110 lb) HE
Range: 0.75-8 n miles (1.5-15 km)
Height: 9-3,000 m (30-10,000 ft)
Guidance: Semi-active radar homing

ANTI-SHIP MISSILES

SS-N-12 (NATO = Sandbox) (Russia = 4K80 Bazalt)

There are sixteen SS-N-12 launch tubes, mounted *en echelon* either side of the bridge structure. The tubes

'Slava' class cruiser Chervona Ukraina. *Armament consists of a twin 130 mm turret, 16 SS-N-12 missiles in fixed containers either side of the bridge, eight SA-N-6 vertical launchers between the stack and the after deckhouse, and two SA-N-4 launchers either side of the hangar* (92 Wing RAAF)

are angled at about 15° and there are no reloads. The SS-N-12 anti-ship missile is a faster and lower flying version of SS-N-3, and has a solid propellant booster to clear the launcher and accelerate it up to cruising speed, with a liquid-fuelled rocket for sustained flight. Target data are acquired through the ship's search radar or from satellites via the Punch Bowl satellite data receiving system. The missile is launched in the general direction of the target and guidance updates are then provided through the 'Front Door', shipborne, F-band (3-4 GHz) missile guidance radar. The missile is reported to be capable of adopting either high- or low-altitude cruise profiles and over-the-horizon (OTH) is possible with the co-operation of targeting aircraft such as Tu-95 'Bear D', Ka-25 'Hormone B' and Ka-27 'Helix B' with Big Bulge I/J-band radar.

Specifications
Length: 11.7 m (38.38 ft)
Diameter: 88 cm (2.89 ft)
Wing span: 2.1 m (6.88 ft)
Weight: 4,600 kg (10,141 ft)
Speed: Mach 1.7
Propulsion: Liquid-fuel rocket, with solid-fuel booster
Range: 296 n miles (550 km) with OTH targeting
Guidance: Inertial (with command updates) and active radar homing
Warhead: 1,000 kg (2,200 lb) HE or 350 kT nuclear

Manufacturer/Contractor
NPO Mashinostroyenia, Russia.

TUBES

Two quintuple 533 mm (21 in) fixed torpedo tubes are mounted in the hull behind shutters.

GUNS

130 mm L/70 guns
All Slavas are fitted with a single twin 130 mm (5 in) mount on the forecastle. The L/70 mounting features two water-cooled 9.1 m (29.9 ft) long barrels of monobloc construction and it seems likely that the mount will carry some 80-90 rounds. The L/70 is an element of a system which includes the fire-control radar with the NATO code-name 'Kite Screech'.

Specifications
(130 mm L/70)
Length of barrel: 70 calibres
Muzzle velocity: 950 m/s (3,118 ft/s)
Traverse: 300° (approximate)
Elevation: −15 to +85°
Weight of shell: 27 kg (59.5 lb)
Rate of fire (mount): 80 rds/min
Range:
anti-surface: 16 n miles (29.5 km)
anti-air: n/k

30 mm AK-630 close in weapon system
There are six AK-630 close in weapon system (CIWS) turrets, two atop the forward deckhouse and two on either side of the mainmast. This multibarrel, high volume-of-fire gun system, has a separate fire-control radar and a below-deck control station with remote optical and/or electro-optical sensor. It fires five types of fire mission: against anti-ship missiles, aircraft, small surface vessels, drifting mines, and unprotected shore targets. The weapon consists of six water-cooled, AO-18 barrels, using the Gatling principle with a fixed breech block and revolving barrels. The magazine contains 2,000 rounds of UOF-84 HE-I and UOR-84 HE-T ammunition, fixed rounds, both of which are fitted with MG-32 point impact fuzes. The gun fires bursts of up to 400 rounds, during which both the barrel and the breech block are cooled, with used cartridges and links being ejected into a bin below the elevating mass. The mounting is unusual in having an ignition system for burning off gun gases accumulating within it during firing.

Specifications
Calibre: 30 mm
Length of barrel: 65 calibres
Muzzle velocity: 890 m/s (2,920 ft/s)
Traverse: 360° (depending on location of turret) at 70°/s
Elevation: −12 to +88° at 50°/s
Crew: 1 (off mount)
Range:
radar fire control: 4,000 m (13,124 ft)
electro-optic fire control: 5,000 m (16,405 ft)
Rate of fire: 4,000-5,000 rds/min
Ammunition:
round: 1.224 kg (2.70 lb)
projectile weight: UOF-84 384 g (0.846 lb); UOR-84 388 g (0.855 lb)

ANTI-SUBMARINE MORTARS

RBU-6000
Known as the Smerch system, the mounting has a similar steel base to the RBU-1000 but with 12 rocket launcher tubes arranged in a circle. The mounting can traverse through 360° and elevation limits are −15 to +60°. Also, as with RBU-1000, loading is automatic from a below-deck magazine. It is estimated that the rockets weigh 110 kg (242.6 lb), with a 25 kg (55.1 lb) warhead. Pairs of tubes are fired in sequence. The RGB-60 rocket is fitted with an impact-time fuze, which detonates either on hitting a solid object (such as a submarine) or reaches a preset depth. Firing is usually conducted in a full salvo of 12 rockets, but it is also possible to fire single rockets, or four- or eight-rocket salvos, if the tactical situation requires it.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Rum Tub
Also carried is the Rum Tub intercept system, consisting of four arrays, each covering a 90° sector. They are mounted at the four corners of the mainmast, between the two pairs of Side Globes.

ELECTRONIC COUNTERMEASURES (ECM)

Side Globe
All four carry eight Side Globe broadband jammers, with two pairs mounted on either side of the mainmast.

Bell series
There is a number of Bell series antennas for IR surveillance.

DECOYS

There are two twin 12-tubed chaff launchers.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS

Satellite data receiving/targeting systems
2 Punch Bowl.

Datalink
Bell Crown

IFF
Salt Pot A and B
Long Head

WEAPONS CONTROL

There are two Tee Plinth and 3 Tilt Pot optronic directors.

SONARS

Bull Horn
Bull Horn is a hull-mounted, active search and attack sonar, operating at low and medium frequencies.

Mare Tail
Mare Tail is a medium-frequency variable depth sonar (VDS), which is deployed from a large door in the stern. It is an active search system, operating at medium frequency.

RADARS

SENSORS		*Ushakov*	*Varyag/Admiral Lobov*
Radars	Air search Air/surface search Navigation	Top Pair Top Steer 3 × Palm Frond	Top Pair Top Plate 3 × Palm Frond
Fire control	SS-N-12 SA-N-6 SA-N-4 130 mm guns 30 mm Gatling	Front Door Top Dome 2 × Pop Group Kite Screech 3 × Bass Tilt	– Top Dome 2 × Pop Group Kite Screech 3 × Bass Tilt
Sonars	Hull-mounted Variable depth	Bull Horn Steer Hide	Bull Horn Steer Hide
IFF		Salt Pot A, B 2 × Long Head	Salt Pot A,B 2 × Long Head

Marshal Ustinov. *At the head of the foremast is Top Steer (the rectangular shape) with a Stout Pair (parabolic shape) back to back. Antennas on the yard-arm (reading from the mast outwards) are: Bell Push ESM system (large radome above and small radome below) and Palm Frond navigation antennas* (L-G Nilsson)

AVIATION

HELICOPTERS

The 'Slava' class has a relatively small helicopter flight deck aft for a single Ka-25Ts (Hormone B) targeting helicopter.

Kamov KA-25Ts* (NATO = Hormone-B)

Specifications
Rotor diameter: 15.74 m (51.64 ft)
Rotor disc area: 194.6 m² (2,095 sq ft)
Length of fuselage: 9.75 m (32.0 ft)
Height to top of rotor head: 5.37 m (17.62 ft)
Operating weight, empty: 4,765 kg (10,505 lb)
Max take-off weight: 7,200 kg (15,873 lb)
Max level speed: 113 kts (209 km/h; 130 mph)
Normal cruising speed: 104 kts (193 km/h; 120 mph)
Service ceiling: 3,350 m (11,000 ft)
Range, with reserves:
standard fuel: 217 n miles (400 km)
external tanks: 351 n miles (650 km)
Power plant: 2–735 kW (986 shp) GTD-3M turboshafts.

Sensors
This variant has special electronics, to enable it to acquire over-the-horizon targets for cruise missiles launched from ships on which it is based. It has a large undernose radome (NATO = 'Big Bulge') with a spherical undersurface. There is also a cylindrical radome under the rear cabin for missile mid-course guidance and the helicopter-to-ship datalink; when the radar is operating, all landing gear wheels are retracted upwards to minimise interference to emissions. There is also a cylindrical fuel container each side of lower fuselage.

Note
*Ts = *tseleukazatel* = targeting

PROPULSION

Specifications
System: Combined gas and gas (COGAG)
Main machinery: 4 gas turbines; 80 MW (108,800 hp(m)); 2 gas turbines; 10 MW (13,600 hp(m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

This design was originally known in the West by its NATO designation of BLACKCOM-1 (Black Sea Combatant #1), following which it was designated Krasina, until the correct Russian designation of 'Slava' became known. Four ships were built at the same yard as the 'Kara' class, all being laid down in 1976, 1978, 1979 and then, following a longer gap, 1984. All were built at the 61 Kommuna Yard at Nikolayev in the Ukraine. The fourth hull was transferred to the Ukrainian Navy while still under construction, but has since been returned to the Russian Navy.

DESIGN

The 'Slava' class was designed as a less radical back-up to the 'Kirov' class battlecruiser, providing most of the facilities of the larger ship in a considerably smaller, gas turbine-powered hull. The main armament is sixteen SS-N-12 (Sandbox) launchers mounted in eight pairs either side of the forward superstructure. These launchers are fixed at an angle of some 15°. Over-the-horizon targeting for SS-N-12 is provided by helicopter or Punch Bowl Satcom.

There is a long gap between the stacks and the after deckhouse, where the eight SA-N-6 launchers are located. These are the same missiles as in the 'Kirov' class but there is only one Top Dome radar for the SA-N-6 SAM system. Since two are required to give 360° coverage (as, for example, in the 'Kirov' class) this means that there is a blind gap in full SAM cover in the forward quadrant. Such a major tactical restriction was probably only accepted on the grounds of saving top weight. As with all Soviet/Russian designs there is a gun armament, in this case twin 130 mm (5 in).

ASW sensors and weaponry are minimal, with only a very basic sonar fit and a very limited range of weapons. The torpedo tubes (located behind shutters in the hull) are only used for torpedoes, while the helicopter

carried is the OTH and not the ASW version. The more usual ASW weapons such as SS-N-15/16 are lacking, as are the heavier types of RBU launcher.

There is a raised flight deck on the stern for the single Hormone-B helicopter. The hangar is forward of the flight deck and half a deck level lower, the helicopter moving between the two along an inclined ramp. The stack is split, with the gap being used to provide stowage for the jib of a large crane. There are air conditioned citadels for NBCD and the bridge is fitted with a periscope.

In most Russian surface warship designs there has been a steady improvement in weapons and sensors over the course of the construction programmes. In the case of the Slava, however, despite the fact that these ships have been constructed over a period of some 15 years, there are only small differences between the individual ships.

NAMES

There has been much changing of names to keep pace with political developments, but despite the name ship of the class, *Slava,* having been renamed *Moskva* (on the retirement of the aircraft-carrying cruiser), the class as a whole retains the name 'Slava'. In summary:

First of class, *Slava (Glory),* had its name changed to *Moskva* in 1995.

The second ship was to have been named *Admiral Lobov,* but this was changed to *Marshal Ustinov* prior to launch. Curiously, despite the fact that Ustinov, the man, was a stalwart of the now discredited Brezhnev era, the ship has (at least so far) retained his name.

The third ship was completed in 1989 as *Chervona Ukraina,* but this name was changed in 1995 to *Varyag,* which had originally been allotted to the second of the 'Kuznetsov' class carriers.

The fourth ship was allocated to the Ukrainian Navy while under construction, but in July 1995 it was agreed that it would be completed for the Russian Navy, which will name it *Admiral Lobov.*

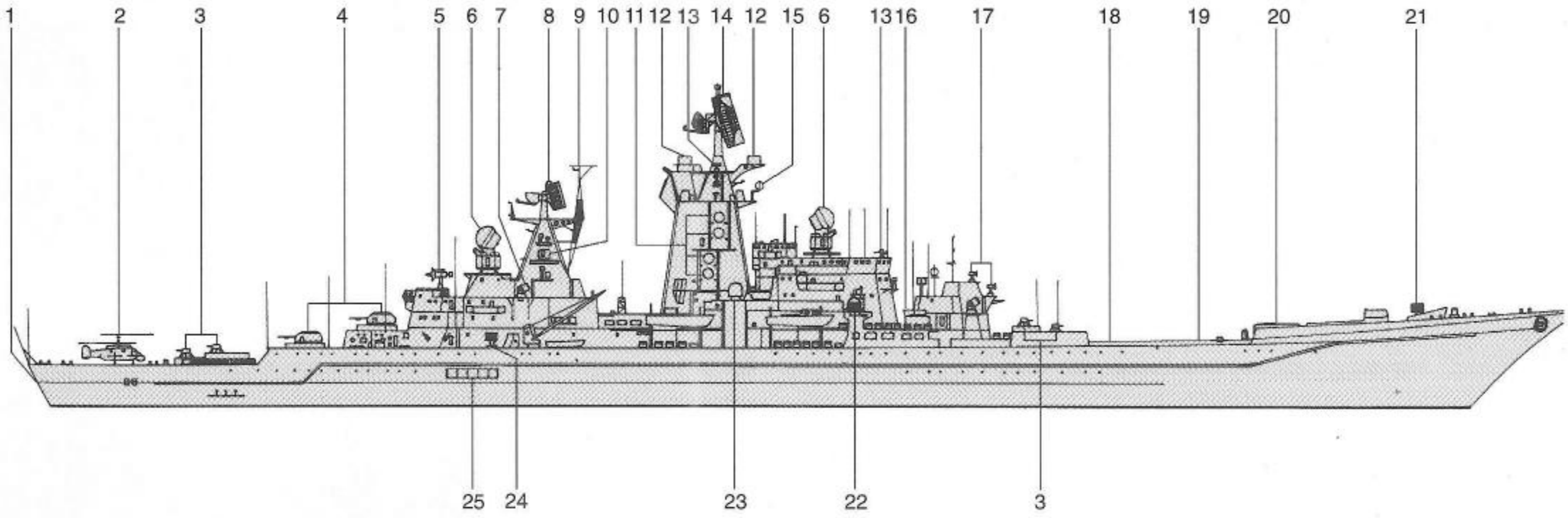
OPERATIONAL

The 'Slava' class was designed as part of a new strategy of creating bastions for SSBNs. The Project 1143 and 1164 ships were to protect these bastions and the new SS-N-12 missile was designed to strike major ASW units.

DEPLOYMENT

One of each of the three current ships is allocated to each main fleet: *Slava* — Black Sea Fleet; *Marshal Ustinov* — Northern Fleet; and *Varyag* — Pacific Fleet. *Marshal Ustinov* is currently in refit in St Petersburg.

KIROV (ORLAN) (TYPE 1144)



Admiral Ushakov (Ian Sturton)

1 *Horse Tail VDS* **2** *Kamov Ka 25 Hormone or Ka 27 Helix* **3** *AK-230 30 mm Gatling CIWS* **4** *100 mm (3.9 in)/59 single turret* **5** *Kite Screech fire director (for 100 mm guns)* **6** *Top Dome fire director (for SA-N-6)* **7** *Bass Tilt fire director (for AK-630 Gatling)* **8** *Top Steer* **9** *Vee Tube HF radio communications* **10** *Tin Man optronic director* **11** *Side Globe (jammers)* **12** *Round House B (Tacan)* **13** *Palm Frond navigation radar* **14** *Top Pair 3D air search* **15** *Quad Loop DF antenna* **15** *SA-N-4 launcher* **17** *Eye Bowl director (SS-N-14)* **18** *20 SS-N-19 vertical launchers* **19** *12 SA-N-6 vertical launchers* **20** *Two SS-N-14 launchers* **21** *RBU-6000 ASW rocket launchers* **22** *Pop Group fire director (for SA-N-4)* **23** *SATCOM* **24** *RBU-1000 ASW rocket launcher* **25** *Five 533 mm (21 in) torpedo tubes*

GENERAL SPECIFICATIONS

Operator: Russia
Type: *atomny raketniy kreyser* (nuclear-powered missile cruiser)

Class: KIROV (Type 1144, 1144.1, 1144.2)

Built: 3
Active: 3
Building: 1

Displacement:
standard: 19,000 t
full load: 24,300 t

Dimensions
Length, overall: 252.0 m (826.8 ft)
Length, waterline: 230.0 m (754.6 ft)
Beam: 28.5 m (93.5 ft)
Draught: 9.1 m (29.5 ft)

Speed: 30 kts
Range: 14,000 n miles at 30 kts
Endurance: 60 days

Complement: 692 (82 officers)

SHIPS

ADMIRAL USHAKOV (ex-Kirov)
Builder Baltic Yard 189, St Petersburg, Russia
Laid down Jun 1973
Launched 26 Dec 1977
Commissioned 30 Dec 1980

ADMIRAL LAZAREV (ex-Frunze)
Builder Baltic Yard 189, St Petersburg, Russia
Laid down 26 Dec 1977
Launched 23 May 1981
Commissioned Jan 1984

ADMIRAL NAKHIMOV (ex-Kalinin)
Builder Baltic Yard 189, St Petersburg, Russia
Laid down May 1983
Launched 26 Apr 1986
Commissioned Dec 1988

PYOTR VELIKIY (ex-Yuri Andropov)
Builder Baltic Yard 189, St Petersburg, Russia
Laid down 25 Apr 1986
Launched 29 Apr 1989
Commissioned 1996

WEAPONS SYSTEMS

ANTI-SHIP MISSILES

SS-N-19 (NATO = Shipwreck) (Russia = P-500 Granit)

20 Granit (SS-N-19) anti-ship missile launch tubes are situated in two groups of ten beneath the foredeck. The missile is believed to have an inertial guidance system, possibly with provision for mid-course guidance in over-the-horizon (OTH) engagements, and active radar terminal guidance.

Mid-course guidance is carried out either by Tu-95 'Bear D' long-range reconnaissance aircraft, or the ship's Ka-25 or Ka-27 helicopters with Big Bulge I/J-band radar. Radar Ocean Surveillance Satellites (RORSAT) may also be used and it is noteworthy that these ships carry 'Punch Bowl' satellite communications systems. Targets can also be acquired by ship sensors, with bearing and range data being fed direct into the missile guidance system. Boosters take the missile in a ballistic trajectory which continues when the jet engine begins to operate, until it achieves an altitude of 20,000 m (65,000 ft) when it enters the cruise phase. The active radar seeker then acquires the target and the missile commences a high-angle dive attack. Some reports suggest the missile seeker may include a home-on-jam capability.

Specifications
Length: 10 m (32.8 ft)
Diameter: 85 cm (33.5 in)
Wing span: n/k
Weight: 3,250 kg (7,165 lb)
Speed: Mach 1.6 (some sources state Mach 2 or Mach 2.5)
Range: 10.8-243 n miles (20-450 km)
Guidance: Inertial with command update and active radar terminal guidance
Warheads: 750 kg HE; fuel-air explosive (FAE) nuclear 500 kT (capable but not carried)

Manufacturer/Contractor
NPO Mashinostroyenia, Russia.

SA-N-6 (NATO = Grumble) (Russia = Fort/Rif) area defence system

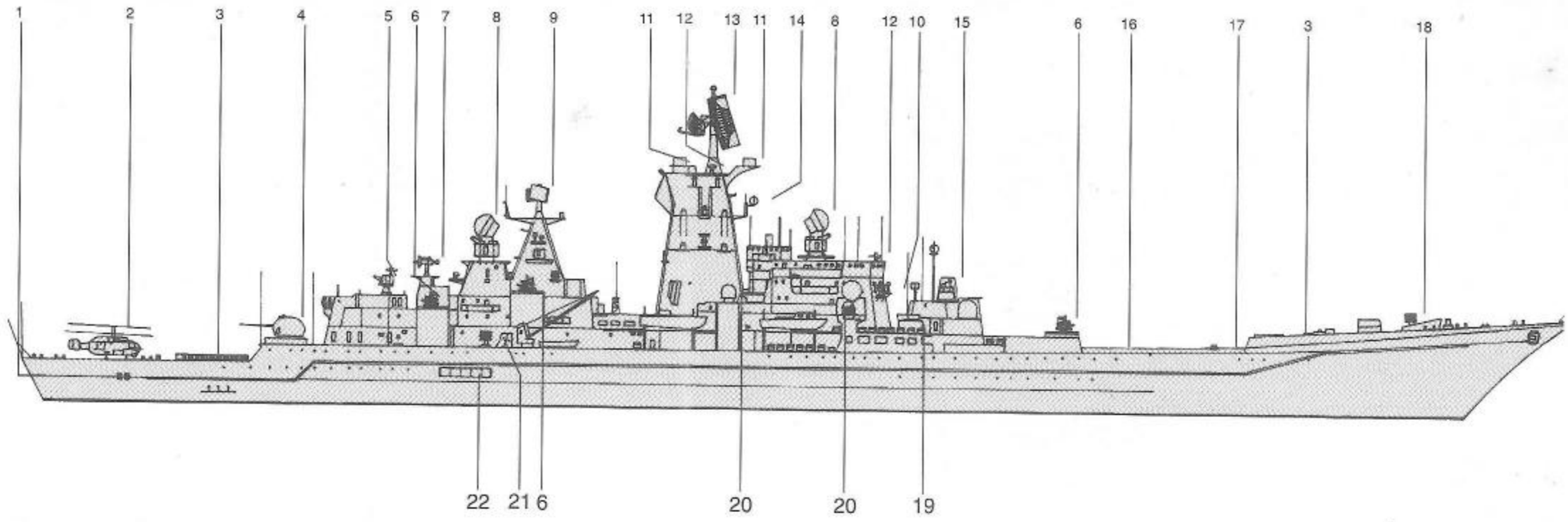
SA-N-6 is designed to provide area cover for a surface task force led by a 'Kirov' class battlecruiser, operating in a hostile environment. It is intended to counter multiple attacks by missile-carrying aircraft and by anti-ship missiles launched by both surface ships and submarines. The system, designated Fort, entered service with the *Kirov* in September 1980.

The S-300PMU missile is powered by a combined booster-sustainer using solid propellant, with an HE fragmentation or optional nuclear warhead, with an active radar seeker. The Kirovs all carry 96 missiles, each of which is mounted vertically in a cylinder, with eight cylinders to a carousel, and twelve carousels under the foredeck, each with its own, square, loading/launching hatch.

Command and control is via the Top Dome system (see below).

Specifications
Length: 7.11 m (23.3 ft)
Diameter: 45 cm (17.7 in)
Wing span: 0.9 m (2.95 ft)
Weight: 1,500 kg (3,307 lb)
Speed: Mach 3
Max range: 48.5 n miles (90 km)
Max altitude: 27,432 m (90,000 ft)
Warhead: 90 kg (198 lb)
Guidance: Command and inertial with semi-active radar track-via-missile

Manufacturers/Contractors
Altair Research and Development Corporation, Russia (systems).
Fakel, Russia (missile).



Admiral Nakhimov (Ian Sturton)
1 *Horse Tail VDS* **2** *Three Kamov Ka-27 Helix* **3** *Two SA-N-9 octuple vertical launchers* **4** *One twin 130 mm/70* **5** *Cross Sword director (for SA-N-9)* **6** *CADS-N-1 30 mm gun/eight SA-N-11 SAM* **7** *Kite Screech (fire director for main guns)* **8** *Top Dome fire control for SA-N-6* **9** *Top Plate 3D air/surface search* **10** *Tin Man optronic director* **11** *Round House B Tacan* **12** *Palm Frond navigation radar* **13** *Top Pair 3D air search radar* **14** *Quad Loop* **15** *Pop Group fire control (for SA-N-4)* **16** *20 SA-N-19 vertical launchers* **17** *12 SA-N-6 vertical launchers* **18** *One RBU-12000 ASW rocket launcher* **19** *SA-N-4 launcher* **20** *SATCOM* **21** *RBU 1000 ASW rocket launcher* **22** *Five 533 mm (21 in) torpedo tubes*

SA-N-4 short-range missile system

There are two SA-N-4 launchers just forward of the bridge. The SA-N-4 has a distinctive loading and launching system in which the twin-rail launcher normally lies beneath a hinged flat cover plate and emerges to launch its missiles, before retracting to reload. This is likely to result in a low rate of fire which must be slowed even further by the need to close the magazine cover before firing. Below the launcher are four revolving drums each with five missiles while the electromechanical and hydraulic machinery is below that.

On launch, the booster burns for 2 seconds allowing the radar to gather the missile at a range of 0.75 n miles (1.5 km), following which the sustainer burns for 15 seconds.

Command and control is via the Pop Group system (see p.482).

Specifications

Length: 3.1 m (10.17 ft)
Diameter: 21 cm (8.27 in)
Wing span: 64 cm (25.2 in)
Weight: 130 kg (286 lb)
Speed: Mach 2.5
Warhead: 50 kg HE (110 lb)
Range: 0.75-8 n miles (1.5-15 km)
Height: 9-3,000 m (30-10,000 ft)
Guidance: Semi-active radar homing

SA-N-9 Gauntlet (Kynshal)

Lazarev, Nakhimov and *Pyotr Velikiy* each have 16 Kynshal (NATO = SA-N-9) point air defence launchers, intended for all-weather use against aircraft, missiles and small craft. It is a modular system consisting of the 9M330 missile, the handling-launcher system and the computer-based radar fire-control system. Each magazine has a single hatch through which the containers are loaded and the missile is launched. For launching, the allocated container is rotated into position below the hatch and the gas-ejection system forces the missile out of the cylinder to a height of 18-20 m above the deck at which point the booster-sustainer comes into operation.

The computer-controlled radar fire-control system is highly automated and apparently uses one computer for the 'Cross Sword' radar system and two to control the remainder of the Kynshal system and to interface with sensors. The manufacturer states that up to four targets travelling at Mach 2 may be engaged simultaneously and that the system can operate up to eight missiles simultaneously. The system can be available in 15 seconds when on alert or 3 minutes from 'cold start' and the response time is 8-24 seconds depending upon the search radar's mode of operation.

Specifications

Length: 3.5 m (11.48 ft)
Diameter: 23.5 cm (9.25 in)
Wing span: 75 cm (29.5 in)
Weight: 165 kg (364 lb)
Warhead: 15 kg (33 lb)
Speed: Mach 2.5

The weapon fit varies between ships, as summarised below:

WEAPON FIT

Weapon type	Designation	*Ushakov*	*Lazarev*	*Nakhimov*	*Pyotr Velikiy*
Surface-to-surface missile launchers	SS-N-19	20	20	20	20
Surface-to-air missile launchers	SA-N-6	12	12	12	12
	SA-N-4	2 × 2	2 × 2	2 × 2	2 × 2
	SA-N-9	-	2 × 8	2 × 8	2 × 8
Combined SAM/Gun mounts	CADS-N-1	—	—	6	6
Guns	100 mm/59	2 × 1	—	—	—
	130 mm/70	—	2 × 2	2 × 2	2 × 2
	30 mm/65	8	8	—	
ASW missile launchers	Twin SS-N-14	1	—	—	—
	SS-N-15	—	✓	✓	✓
Torpedo tubes	533 mm/21 in	2 × 5	2 × 5	2 × 5	2 × 5
ASW mortars	RBU 6000	1	1	—	—
	RBU 12000	—	—	1	1
	RBU 1000	2	2	2	2
Helicopters	Ka-25 Hormone B	1	1	1	1
	Ka-27 Helix A	2	2	2	2

Range: 0.5-6.5 n miles (1.5-12 km)
Altitude: 6,000 m (20,000 ft)
Guidance: Command guidance

Manufacturers/Contractors

Altair Research and Development Corporation, Russia (system).
Fakel, Russia (missile).

SA-N-11 'Grissom'/CADS-N-1 (Kashtan/Kortika) close in weapon system

The Kashtan combined missile/gun system is mounted only in *Pyotr Velikiy* and is designed for point defence against anti-ship missiles and guided bombs to distances up to 2 n miles (4 km) and consists of an above-deck combat module and a below-deck command module. The combat module is on a deck mounting on which it can turn 360° in azimuth. On either side of the module is a 2A38M 30 mm calibre water-cooled gun which is capable of elevation only. Above each gun is a mounting for four launcher-containers (each weighing 60 kg (132.3 lb)) for the 9M311 (NATO = SA-N-11) surface-to-air missiles. These are two-stage, solid-propellant missiles with a 'fragmentation/multiple rod type' warhead with a proximity fuze, activated when the missile is within 5 m of the target. There is a blast deflector at the rear of the missile mounting.

Specifications

SA-N-11 missile
Length: 2.56 m (8.4 ft)
Diameter: 17 cm (6.70 in)
Wing span: n/k
Weight: 57 kg (125.7 lb)
Speed: Mach 2.6
Range: 4.5 n miles (8 km)
Guidance: Radar to command-line-of-sight

Gun 2A38M gun
Length: 3.48 m (11.42 ft)
Weight: 223 kg (491.6 lb)
Cyclic rate of fire: 1,950-2,500 rds/min
Muzzle velocity: 960 m/s (3,150 ft/s)
Effective range: 2 n miles (4 km)
Effective altitude: 200-2,000 m (656-6,560 ft)
Magazines: 1,900 rds each

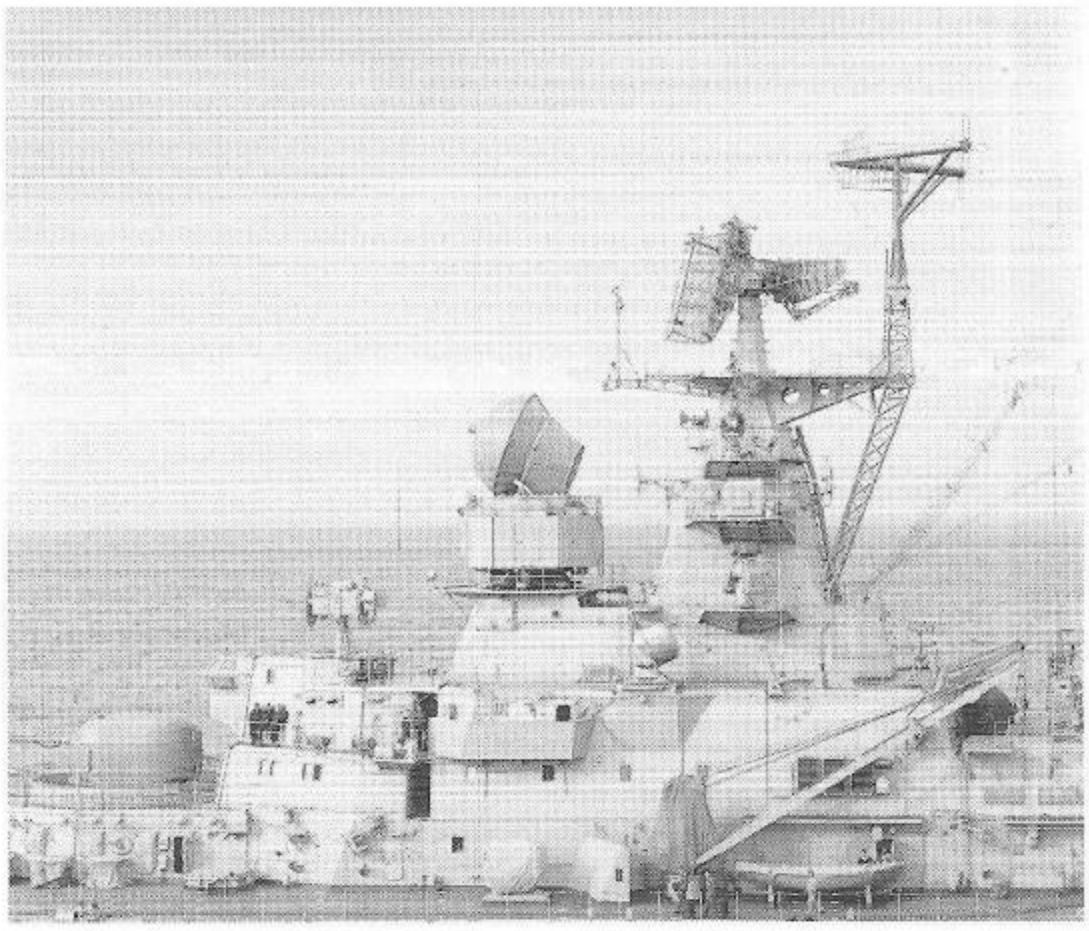
Manufacturers/Contractors

Ministry of Radio Industry, Russia.
Scientific Production Corporation Phasotran, Russia.

SS-N-14 (NATO = Silex) (Russia = 60-RU/70-RU/80-RU/85-RU Rastrub)

SS-N-14 is a long-range torpedo delivery system: 60-RU, 70-RU and 80-RU are anti-submarine versions, 85-RU is the anti-ship version. *Ushakov* only has two SS-N-14 ('Silex') launchers, each with seven missiles, which are installed in the foredeck. The system consists of a missile and weapon handling-launching system and a computer-based guidance system which is probably associated with surface-to-air missile guidance systems.

The missile is powered by a solid propellant booster-sustainer and has an autopilot which can be updated in



The mainmast of Kirov *. The large antenna at the masthead is Top Steer which consists of a frequency scanned D/E band antenna mounted back to back with a Stout Pair antenna. To the right of Top Steer is Vee Tube, a long-range HF communications antenna. On the three platforms below Top Steer are: a searchlight; the box-like Fly Screen helicopter landing-control system and a Tin Man optronic director. Below and to the left of Tin Man is a Bass Tilt fire-control radar. To the left of Top Steer are: Top Dome missile director, Kite Screech fire-control director for the 100 mm guns and a 100 mm/59 turret. At deck level and to the left of the crane are a shrouded RBU 1000 six-tubed ASW rocket launcher and its associated blast screen* (US Navy)

Forward of Kirov's *bridge are two Eye Bowl fire-control directors, flanked by a Bass Tilt director and its associated 30 mm Gatling CIWS. Inset in the fore-deck are 20 vertical launch tubes for SS-N-19 and (to the right of the man in dark clothing) 12 launch tubes for SA-N-6* (US Navy)

flight. SS-N-14 is fitted in various types of Russian ship and the launching methods differ, but in *Ushakov* the missiles are launched from a twin-tube launcher, which can be elevated and may also be trained in azimuth. There are two launch tubes with a reload capability with a total capacity of 14 missiles.

The missile carries a torpedo, which is faired into the underside of the airframe and the different designations indicate the payload: 60-RU with 100 kT depth charge; 70-RU with ASW torpedo; 80-RU with ASW torpedo; 85-RU dual role. In the ASW versions the weapon, which requires only 15 seconds warm-up time, is launched to an altitude of some 750 m (2,460.1 ft) and is then guided towards the approximate location of the target by radio command, where the torpedo is ejected. The torpedo is retarded by the parachute and then descends vertically to the surface, where the parachute is disconnected and the weapon begins a search pattern to acquire the target.

The 85-RU version possesses alternative anti-submarine/anti-ship modes. The ASW attack profile is the same as that described above, but in the anti-ship role the torpedo ejection system is overridden and radio commands continue to guide the missile towards the target until its IR seeker can acquire it. The whole missile hits the target, with the torpedo warhead providing the main destructive effect, supplemented by the mass of the missile and the explosive effect of the unexpended fuel.

Specifications
SS-N-14
Length: 7.2 m (23.62 ft)
Diameter: 0.574 m (1.88 ft); (1.35 m (4.43 ft) with torpedo)
Launch weight: 4,000 kg (8,818 lb)
Wing span: n/k
Range:
anti-submarine: 30 n miles (55 km)
anti-ship: 19 n miles (35 km)
Speed: Mach 0.95
Guidance: Autopilot and command update

Type E53 torpedo
Range: 8.1 n miles (15 km)
Speed: 40 kts
Homing: Active/passive
Warheads:
anti-submarine: 150 kg (330 lb) HE; or 5 kT nuclear
anti-ship: 500 kg (1,102 lb) HE
Propulsion: Electrical

SS-N-15 (NATO = Starfish) (Russian = 90-RU Tsakra Veder) ASW weapon delivery system

The 'Starfish' long-range anti-submarine weapon system is installed in *Lazarev, Nakhimov* and *Pyotr Velikiy,* where it is fired from torpedo tubes located behind shutters in the superstructure, but not *Ushakov.* The missile is launched from a standard 533 mm (21 in) torpedo tube, but is believed to be otherwise similar in concept and shape to SUBROC, having a long, slim cylinder with small, retractable fins and a booster rocket at the end. There are two payloads, either a Type 45 torpedo or a 200 kT nuclear depth charge, although under current international agreements, nuclear warheads are now not taken to sea. Presumably Russian ships, like their American counterparts, retain the ability to be reclassified for their use in an emergency.

Specifications
Length: 6.5 m (21.32 ft)
Diameter: 533 mm (21 in)
Wing span: n/k
Weight: 1,800 kg (3,968 lb)
Range: 24-27 n miles (45-50 km)
Speed: n/k
Guidance: Inertial

TUBES

Two quintuple 533 mm (21 in) fixed tubes are mounted in the hull behind shutters, which can launch either SS-N-15/16 missiles or Type 40 torpedoes. The installations are on either quarter and are adjacent to the RBU-1000s, which appear to be part of a combined system designed for both ASW and anti-torpedo defence.

GUNS

100 mm (3.9 in) L/70

Ushakov has a gun armament of two 100 mm guns in single turrets, mounted aft, where their forward arcs of fire are severely limited. The turret is unmanned but there is an electro-optic sensor at the front to the left of the elevating mass and the below-decks installation probably penetrates about 5 m (16.4 ft). The L/70 is associated with a fire-control radar with the NATO codename 'Kite Screech'.

Specifications
(L/70)
Length of barrel: 70 calibres
Muzzle velocity: 850 m/s
Traverse: 300° (approx)
Elevation: −10 to +85°
Weights:
shell: 16 kg (35.27 lb)
projectile: 6.8 kg (14.99 lb)
Rate of fire: 80 rds/min
Range:
anti-surface: 8 n miles (15 km)
anti-air: 8,000 m (26,000 ft)

130 mm L/70 guns

The last three ships of the class have a single twin 130 mm mount in place of the two single 100 mm mounts in *Ushakov.* As with *Ushakov,* this mount is aft overlooking the helicopter flight deck, and the forward arc is totally blocked by the superstructure. The L/70 mounting features two water-cooled 9.1 m long barrels of monobloc construction and it seems likely that the mount will carry some 80-90 rounds. The L/70 appears to be part of a system which includes the fire-control radar with the NATO codename 'Kite Screech'.

Specifications
(130 mm L/70)
Length of barrel: 70 calibres
Muzzle velocity: 950 m/s
Traverse: 300° (approx)
Elevation: −15 to +85°
Weight of shell: 27 kg (59.5 lb)
Rate of fire (mount): 80 rds/min
Range:
anti-surface: 16 n miles (29.5 km)
AA: n/k

30 mm AK-630 close in weapon system

The AK-630 close in weapon system (CIWS) is fitted in *Ushakov* and *Lazarev,* with eight single mounts in two groups of four at either end of the main superstructure. The AK-630 close in weapon system is a multibarrel, high volume-of-fire gun system, with a separate fire-control radar and a below-deck control station with remote optical and/or electro-optical sensor. It fires five types of fire mission: against anti-ship missiles, aircraft, small surface vessels, drifting mines, and unprotected shore targets. The weapon consists of six water-cooled, AO-18 barrels, using the Gatling principle with a fixed breech block and revolving barrels. The magazine

Specifications

	RBU-1000	RBU-6000	RBU-12000
Launch tubes	6	12	10
Tube arrangement	Two vertical rows of 3	Circular	Horseshoe
Calibre	300 mm (11.8 in)	212 mm (8.34 in)	n/k
Tube length	1.8 m (5.9 ft)	1.83 m (6.0 ft)	n/k
Elevation	+40°	−15 to +60°	n/k
Traverse	360°	360°	n/k
Rocket weight	90 kg (198.4 lb)	110 kg (242.5 lb)	—
Warhead	55 kg (121.25 lb)	25 kg (55.1 lb)	80 kg (176.4 lb)
Range	0.5 n miles (1,000 m)	3.25 n miles (6,000 m)	6.5 n miles (12,000 m)

bomb launcher), followed by a figure suffix giving the nominal range in metres.

RBU 1000

This mounting has two vertical rows of three tubes on each side of a pedestal. Loading from the below-deck magazine is automatic, with the tubes being raised to the vertical and the loading mechanism inserting the 90 kg (198 lb) rockets in sequence. The mountings are on the ship's quarters, adjacent to the torpedo tubes and may combine ASW with anti-torpedo missions, launching noise-makers.

RBU-6000

Known as the Smerch system, the mounting has a similar steel base to the RBU-1000 but with 12 rocket launcher tubes arranged in a circle. The mounting can traverse through 360° and elevation limits are −15 to +60°. Also, as with RBU-1000, loading is automatic from a below-deck magazine. It is estimated that the rockets weigh 110 kg (242 lb), with a 25 kg (55 lb) warhead. Pairs of tubes are fired in sequence. The RGB-60 rocket is fitted with an impact-time fuze, which detonates either on hitting a solid object (such as a submarine) or reaches a preset depth. Firing is usually conducted in a full salvo of 12 rockets, but it is also possible to fire single rockets, or four- or eight-rocket salvos, if the tactical situation requires it.

RBU-12000

Few details of this mounting have been published, but it has 10 launcher tubes either side of a box which presumably contains the elevation gears and is itself mounted on a steel pintle. The automatic reloading system is likely to work in the same manner as that of the RBU 1000/RBU 6000. The mounting is normally associated with bow-mounted Horse Jaw, hull-mounted, LF active search and Horse Tail MF, active search VDS.

contains 2,000 rounds of UOF-84 HE-I and UOR-84 HE-T ammunition, fixed rounds, both of which are fitted with MG-32 point impact fuzes. The gun fires bursts of up to 400 rounds, during which both the barrel and the breech block are cooled, with used cartridges and links being ejected into a bin below the elevating mass. The mounting is unusual in having an ignition system for burning off gun gases accumulating within it during firing. Unlike Phalanx, the AK-630 features a separate radar director which has the NATO code-name 'Bass Tilt'.

Specifications
Calibre: 30 mm
Length of barrel: 65 calibres
Muzzle velocity: 890 m/s (2,920 ft/s)
Traverse: 360° (depending on location of turret)
Elevation: −12 to +88°
Traverse speed: 70°/s
Elevation speed: 50°/s
Crew: 1 (off mount)
Range:
radar fire control: 4,000 m (4,374 yd)
electro-optic fire control: 5,000 m (5,470 yd)
Rate of fire: 4,000-5,000 rds/min
Ammunition:
round: 1.224 kg (2.7 lb)
projectile weight: UOF-84 384 g (0.85 lb); UOR-84 388 g (0.86 lb)

ANTI-SUBMARINE MORTARS

All four ships are fitted with close in anti-submarine rocket launchers, whose Russian designation is *Raketnaya Bombometnaya Ustanovka* (rocket depth

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Rum Tub

Also carried by *Ushakov* alone is the Rum Tub intercept system, consisting of four arrays, each covering a 90° sector. They are mounted at the four corners of the mack above the uppermost pair of Side Globes.

Foot Ball

There are eight Foot Ball radomes, but not in *Ushakov*.

ELECTRONIC COUNTERMEASURES (ESM)

Side Globe

Ushakov alone carries eight Side Globe broadband jammers, with two pairs mounted on either side of the mack.

Wine Flask

Wine Flask is the follow-on generation of jammer to the Side Globe/Rum Tub series. Four are installed in *Lazarev, Nakhimov* and *Pyotr Velikiy*.

Bell Bash

There are eight Bell Bash and four Bell Nip ESM antennas. Such antennas are usually associated with jammers.

Half Cup

Half Cup is a laser intercept device.

DECOYS

Two twin 150 mm chaff launchers.
Towed torpedo decoy.

The bridge and foremast of Admiral Ushakov *(formerly* Kirov*). Sensors on the tower mast, from top to bottom are: Top Pair 3D air search radar (combination of Top Sail and Big Net arrays); two Round House B TACAN, with Palm Frond navigation antenna between; level with yard-arms are four Rum Tub ESM/ECM arrays together with a number of Bell-series ESM antennas and a Quad Loop forward; the white dome below the lowest Side Globe houses a Satcom antenna. On the bridge roof is a Top Dome missile director with a small Palm Frond navigation radar above the bridge windows. On the forward face of the bridge are two Tin Man optronic sensors and to the left of the starboard Tin Man is a Pop Group missile-guidance radar for the SA-N-4 missile, one launcher of which is beneath the round hatch immediately below the Tin Man* (US Navy)

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Top Dome

The command and control system is based upon the 'Top Dome' J-band (10-20 GHz) multifunction director group of which there are two in the 'Kirov' class. The system consists of a primary antenna in a hexagonal, stabilised mounting some 4 m (13 ft) in diameter, which can be steered mechanically in azimuth but is fixed at an angle of 20° in elevation. At the front of this mounting are three antennas of semi-cylindrical appearance as well as a thimble-shaped antenna. The top antenna tracks both the target and the missile while the thimble-shaped antenna is the link transceiver for the track-via-missile system. The other antennas probably control two missiles apiece with tracking of both targets and missiles conducted on a time-share basis. The group is believed to be capable of long-range tracking and guidance while multimode operating facilities are probably included. It is reported that between four and six missiles can be controlled simultaneously by one system. The command and control system is based upon multiple processors which also include a diagnostic, BITE, and simulators. The MMI consists of radar and alphanumeric displays and dedicated switches. The system interfaces with the ship's search radars, pitch and roll angle data transmitters as well as heading sensors and the ship's log. The search radar will usually detect targets that are allocated by the ship's command staff. However, the 'Top Dome' system also possesses a search mode which may be used when the ship's primary air search radar is off line. It is believed that targets may also be detected by ESM systems as well as electro-optic sensors such as the 'Tin Man.' The 'Top Dome' system turns to the appropriate bearing, acquires the target (if it has not already done so) and locks on. It can track up to six targets simultaneously. The Rif processing system simultaneously selects the missile/launcher combination for the engagement and during pre-launch preparation it inserts into the guidance system the direction and angle of interception. After turnover the missile's semi-active seeker receives the reflected radar signal and retransmits it to the Rif processing system. This processes the data and transmits course corrections with track-via-missile mode used in the terminal phase although this may be replaced in later versions by an active radar seeker. Up to six targets can be engaged simultaneously with two missiles assigned to each target.

Pop Group

The system is a frequency-agile monopulse radar with a parabolic rotating search radar operating in H-band (6-8 GHz) and with a typical acquisition range of 16 n miles (30 km). There are two J-band (10-20 GHz) antennas, one of them for a pulse Doppler target-tracking element with a range of 10.75 n miles (20 km) and the smaller parabolic antenna being used to track the missile. Above the prime antennas is a smaller, circular antenna which transmits an I-band (8-10 GHz) uplink capture beam, which gathers the missile shortly after launch. The director also has a small, rectangular command uplink emitter. The probable engagement sequence is that the target is acquired by the 'Pop Group' air search radar and the data is then displayed on a panoramic display in the operator's console where it is designated either automatically or manually. The missiles are usually launched in pairs, with one of the 'Pop Group' antennas automatically illuminating the target, the second the missile and transmitting command signals.

Cross Sword

Cross Sword is the control system for SA-N-9, with the command post directly below the radar pedestal and including one console for the system commander and at least five for the radar operators. The 'Cross Sword' consists of two large boxes of electronics with an oval-shaped phased array antenna installed on the front of one at an angle of 22.5°. This is a front-feed K-band (20-40 GHz) tracking radar and above it are two drum-shaped antenna, the larger one on the right probably tracking the missile while the smaller one on the left is the uplink transmitter. On a separate pedestal on top of the boxes are two parabolic lattice antennas, mounted back to back, for the C-band (0.5-1 GHz) monopulse search radar. Two electro-optic sensors are at the base of the tracking antenna for operating the system in severe electronic environments. Each silo of magazines is supported by one 'Cross Sword' complex. Although the prime weapon is the Tor-M (SA-N-9) missile, Kynshal can also be used to control the AK-630 close in weapon system.

Hot Flash

The sensor fit differs from 2S6M, with the army radar, given the NATO codename 'Hot Shot', replaced by the 'Hot Flash' radar which features two paraboloid antennas with front horn feeds. The central one is probably a search radar, to detect and track sea-skimming missiles, while the one mounted to the right of it is probably the missile guidance radar. The transmitter and receiver electronics are mounted behind the antennas. To the left of the central radar antenna are two electro-optic sensors which are probably a laser rangefinder and a remotely operated TV camera. Targets are probably designated through the ship's prime air search radar. The target is acquired through the search radar and at ranges of 1,500 to 8,000 m (4,921 to 26,248 ft) it will be engaged by missiles using radar or TV tracking, with the missiles probably launched in pairs for increased kill probability. Guns will engage targets at closer ranges down to 500 m (1,640.5 ft). According to Russian publicity material the highly automated system can engage up to six targets per minute. Russian sources state the 2S6M can engage targets flying at a maximum speed of 500 m/s (1,640.5 ft) with the complete system having a reaction time of eight seconds and a similar performance may be expected from the Kashtan.

Kite Screech

Both the twin single 100 mm mounts in *Ushakov* and the single twin 130 mm mount in the other three ships, use the 'Kite Screech' gun control system. This is a G/I-band radar which is probably an evolutionary development of 'Owl Screech/Hawk Screech', which appears to incorporate monopulse tracking. It features a circular dish antenna, with central feed, behind which are transmitter, receiver, turning and stabilisation gear housings. All are mounted upon a pedestal which is about 2 m (6.6 ft) high. One such radar controls up to two guns and it is likely that the radar compartment for this sensor also acts as the fire-control centre. In the shore bombardment role it may be used with the electro-optic sensor which has the NATO codename 'Squeeze Box'.

Bass Tilt

Bass Tilt is an H-band system with its director mounted on a pedestal and its antenna with a drum-shaped radome 1.2 m (3.9 ft) in diameter inclined at an angle of approximately 45°. The director is 2 m (6.6 ft) high and 1.45 m (4.76 ft) long. The radar is probably linked to a ballistic computer and each director controls up to two gun mountings. In some ships the same fire-control system appears to be expanded to include the AK-176. In addition to the radar there is a fall-back optical and/or electro-optical control system, the latter possibly based upon the sensor with the NATO code-name 'Tee Plinth'.

COMMUNICATIONS

These ships all carry the large range of communications facilities normally associated with a flagship.

Vee Cone

Ushakov alone mounts this large high-frequency (HF) antenna.

Punch Bowl

All four have two Punch Bowl on a special pedestal amidships.

Low Ball

All have four Low Ball Satnav antennas.

Salt Pot A and B

Interrogative, friend or foe (IFF).

Round House B

TACAN; two sets.

WEAPONS CONTROL

All four ships have four Tin Man optronic trackers. Two are on the front side of the bridge structure and two either side of the main mast.

SONARS

Horse Jaw

Horse Jaw is a hull-mounted, active search and attack sonar. It operates at low/medium frequency.

Horse Tail

The Horse Tail variable depth sonar (VDS) is deployed through a large door in the stern. It is an active search, medium-frequency system, operating at depths of between 150-200 m (492-656 ft) depending on the ship's speed.

RADARS

SENSORS		*Ushakov*	*Lazarev*	*Nakhimov*	*Pyotr Velikiy*
Radars	Air search Air/surface search Navigation	Top Pair Top Steer 3 × Palm Frond	Top Pair Top Steer 3 × Palm Frond	Top Pair Top Plate 3 × Palm Frond	Strut Pair Top Plate
Fire control	SS-N-14 SA-N-9 SA-N-6 SA-N-4 130 mm guns 30 mm Gatling	2 × Eye Bowl — 2 × Top Dome 2 × Pop Group Kite Screech 4 × Bass Tilt	— 2 × Cross Sword 2 × Top Dome 2 × Pop Group Kite Screech 4 × Bass Tilt	— 2 × Cross Sword 2 × Top Dome 2 × Pop Group Kite Screech 6 × Hot Flash	— 2 × Cross Sword 2 × Top Dome 2 × Pop Group Kite Screech 6 × Hot Flash
Sonars	Hull-mounted Variable depth	Horse Jaw Horse Tail	Horse Jaw Horse Tail	Horse Jaw Horse Tail	Horse Jaw Horse Tail
Aircraft control		Fly Screen B	Fly Screen B	Fly Screen B	Fly Screen B

AVIATION

AVIATION FACILITIES

There is a large flight deck at the stern. The hangar is below and is accessed by an elevator, just forward of the flight deck. The elevator platform is covered by a two-section hatch, enabling the deck space to be used, even when the elevator is at the hangar level.

HELICOPTERS

The 'Kirov' class air wing normally comprises three helicopters: two Ka-27PL (Helix-A) and one Ka-25 (Hormone-B).

The Ka-27PLs are ASW aircraft, while the Hormone B's primary mission is to provide over-the-horizon targeting for the SS-N-19 missiles.

*Kamov Ka-27PL * (NATO = Helix A)*

Specifications
Rotor diameter: 15.90 m (52.16 ft)
Rotor disc area: 397 m² (4,275 sq ft)
Fuselage length: 11.30 m (37.07 ft)
Height to rotor head: 5.40 m (17.72 ft)
Operating weight, empty: 6,500 kg (14,330 lb)
Max take-off weight: 12,600 kg (27,778 lb)
Max payload: 5,000 kg (11,023 lb)
Max level speed at optimum altitude: 135 kts (250 km/h)
Endurance: 4.5 h
Engines: 2 Klimov (Isotov) TV3-117V turboshafts, each 1,645 kW (2,205 shp)
Accommodation: 3 (pilot plus 2)
Sensors: Surface search radar, sonobuoys, dipping sonar
Weapons: Torpedoes (3), nuclear or conventional depth bombs or mines

Note
PL = protivolodochny = submarine

*Kamov KA-25Ts * * (NATO = Hormone-B)*

Specifications
Rotor diameter: 15.74 m (51.64 ft)
Rotor disc area: 194.6 m² (2,095 sq ft)
Length of fuselage: 9.75 m (32.0 ft)
Height to top of rotor head: 5.37 m (17.62 ft)
Operating weight, empty: 4,765 kg (10,505 lb)
Max take-off weight: 7,200 kg (15,873 lb)
Max level speed: 113 kts (209 km/h; 130 mph)
Normal cruising speed: 104 kts (193 km/h; 120 mph)
Service ceiling: 3,350 m (11,000 ft)
Range, with reserves:
standard fuel: 217 n miles (400 km)
external tanks: 351 n miles (650 km)
Power plant: 2—735 kW (986 shp) GTD-3M turboshafts

Sensors
This variant has special electronics to enable it to acquire over-the-horizon targets for cruise missiles launched from ships on which it is based. It has a large undernose radome (NATO = 'Big Bulge') with a spherical undersurface. There is also a cylindrical radome under the rear cabin for missile mid-course guidance and the helicopter-to-ship datalink; when the radar is operating, all landing gear wheels are retracted upwards to minimise interference to emissions. There is also a cylindrical fuel container each side of lower fuselage.

Note
*PL = *protivolodochny* = submarine (anti)
**Ts = *tseleukazatel* = targeting

PROPULSION

Specifications
System: Combined steam and nuclear (CONAS)
Reactors: 2 KN-3 pressurised water reactors (PWR), 300 MW
Boilers: 2 oil-fired boilers
Steam turbines: 2 GT3A-688 steam turbines; 103 MW (140,000 hp(m))
Shafts: 2

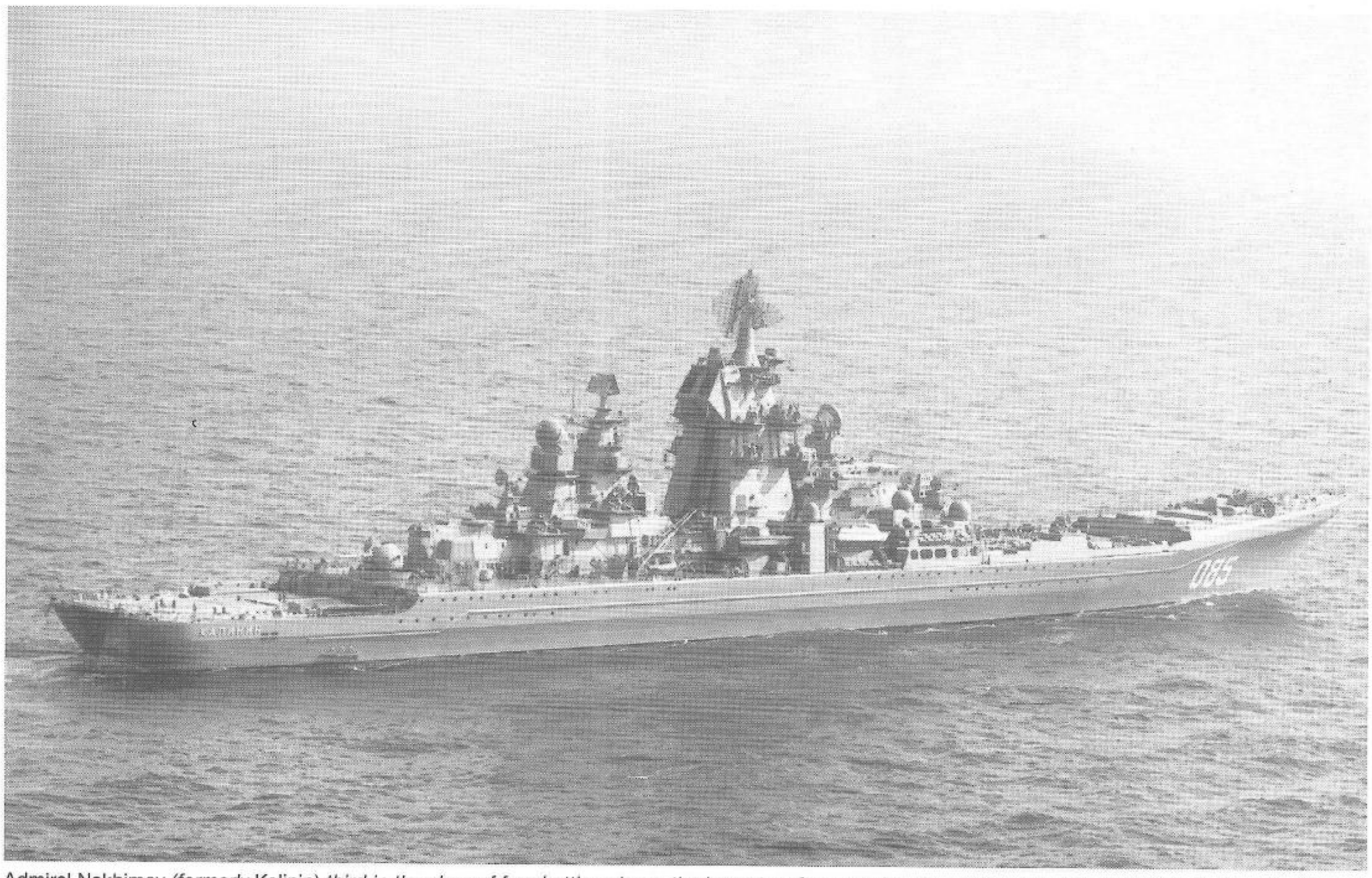
FURTHER INFORMATION

PROGRAMME

These are the largest surface warships, apart from aircraft carriers, built since the Second World War. The programme has been particularly protracted, with thirteen years separating the first and last of the class and there are considerable differences between them. Having constructed the four Kirovs, in 1989-90 the Baltic Yard started to build eight 'Kronstadt' class ro-ro ships for civilian use, thus confirming statements that only four were to be built, although *Pyotr Velikiy* (Peter the Great) is still not completely fitted out.

All four were renamed in May 1992. They had originally carried names of Communist heroes — *Kirov, Frunze, Kalinin* and *Yuri Andropov* — but with the demise of communism in the 1980s these names were considered no longer appropriate. They were, therefore, changed to Russian naval heroes — *Admiral Ushakov, Admiral Lazarev, Admiral Nakhimov,* and *Pyotr Velikiy* (Peter the Great), respectively — although they are still known in the West as the 'Kirov' class.

It is possible that at least two more were planned, of which the fifth of class, *Dzerzhinsky,* was laid down in 1989, although construction was suspended later that year and never restarted.



Admiral Nakhimov *(formerly* Kalinin*) third in the class of four battlecruisers, the largest surface warships (apart from aircraft carriers) built since the Second World War*

DESIGN

With a full load displacement of 28,000 tonnes, these are the largest surface combatants to be completed since the French battleship, *Jean Bart* (49,850 tons), in 1949. The design was too large to be described as a cruiser, and too lightly armoured to fit in with the traditional concept of a battleship and thus fitted most appropriately into the category of 'battlecruiser', of which the most recent examples had been the two ships of the US Navy's 'Alaska' class (34,253 tons) commissioned in 1944.

The weapon fit is exceptionally heavy, but the Russian Navy has clearly had reservations about it, as there have been repeated changes in order to optimise its capabilities. The principle offensive weapons system is the SS-N-19, with 20 launch tubes mounted at an angle of approximately 45° in the foredeck. *Lazarev* and subsequent ships have a modified superstructure and armament, although the SS-N-19 and SA-N-6 missile fits are the same as in the first of class.

Lazarev has two SA-N-9 octuple launchers, one in place of *Ushakov's* bow-mounted SS-N-14 and the second aft in place of four 30 mm AK-630 CIWS turrets, which have been moved to a lengthened after deckhouse. In *Nakhimov* and *Pyotr Velikiy* the CIWS has been changed completely, and now comprises six CADS-N-1 mountings, each with two 30 mm cannon and eight missile launchers. Two are mounted either side of the SS-N-19 forward and four on the after superstructure.

All ships except *Ushakov* have the same anti-submarine system as the frigate *Neustrashimy,* with fixed torpedo tubes in ports behind shutters in the superstructure for firing SS-N-15 or Type 45 torpedoes.

In line with Russian naval practice there is a heavy concentration on electronic warfare (EW) equipment, with individual elements changing over the years.

These were the first Russian surface warships to be fitted with nuclear propulsion; a unique form of combined nuclear and steam propulsion. There are two nuclear reactors which give a normal maximum speed of 24 knots, but there are, in addition, two auxiliary oil-fuelled boilers, and a steam superheating system can be cut in to boost the normal steam output by approximately 50 per cent and raise the maximum speed to 32 knots.

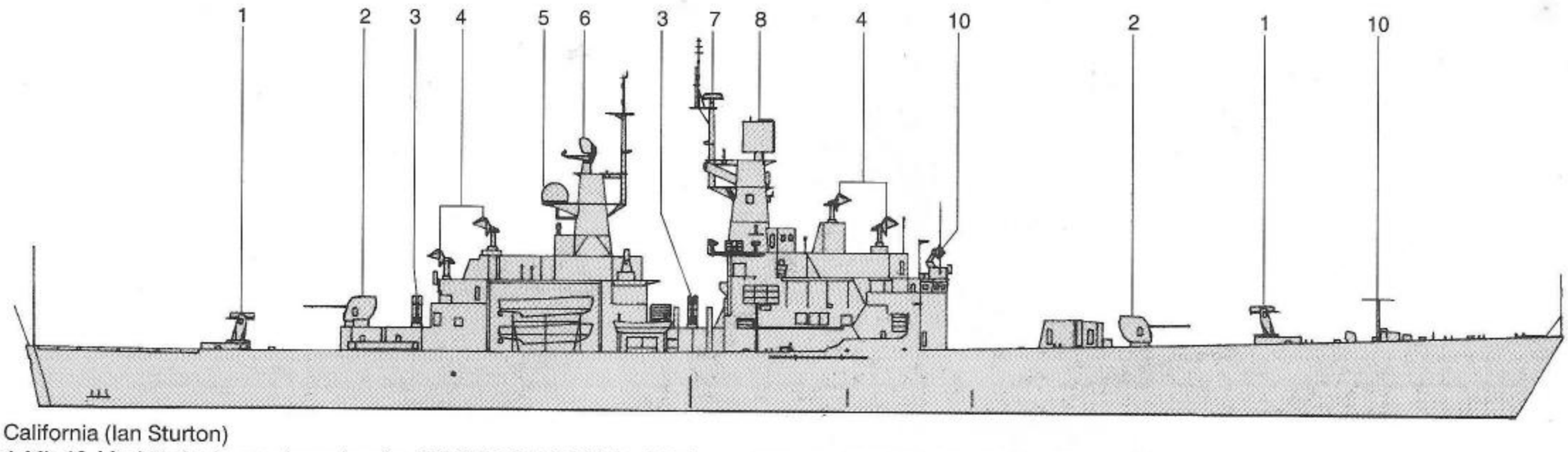
OPERATIONAL

These ships were originally designed to control SSBN bastions, commanding surface action groups operating on the seaward side of the gaps.

The CIWS in *Nakhimov* is an attempt further to improve inadequate hard-kill air defences in *Ushakov,* following the installation of SA-N-9 in *Lazarev.* Over-the-horizon targeting for SS-N-19 provided by Satcom or helicopter. *Ushakov* and *Nakhimov* are in the Northern Fleet, *Lazarev* in the Pacific and *Pyotr Velikiy* may start sea trials in the Baltic in 1995. *Ushakov* has been inactive in Murmansk since a propulsion accident in late 1990 but has been kept in good condition. These ships are expensive to man and maintain and spend little time at sea. *Lazarev,* which is due for a refit, may have been scrapped in 1995.

These are the largest surface warships, apart from aircraft carriers, to have been built since the Second World War, and illustrate Russian warship designers' capability for daring and innovative thinking. Their CONAS power plant is unique and their concentration of weapons systems makes them extremely powerful ships. How they might have fared in general war is a matter for speculation. Indeed, despite their magnificent appearance, the immense variety of their weapons systems,and the variety and capability of their electronic systems, which would have made them focal points for NATO attacks, they could well have shared the fate of the Second World War battleships, such as the German *Bismarck* and the Japanese *Yamato.*

CALIFORNIA



California (Ian Sturton)
1 *Mk 13 Mod 7 single arm launcher for SM-2MR SAM* **2** *United Defense 127 mm (5 in)/54 Mk 45 Mod 0 gun* **3** *Four Harpoon anti-ship missile launchers* **4** *AN/SPG 51D fire-control directors (for SM-2MR)* **5** *Lockheed AN/SPQ-9A fire-control radar* **6** *Raytheon AN/SPS-49(V)5 air search radar* **7** *Norden AN/SPS-67 surface search radar* **8** *ITT AN/SPS-48E 3D air search* **9** *AN/SPG-600 fire-control radar for Mk 86 fire-control system* **10** *AS-2865 NTDS antenna*

GENERAL SPECIFICATIONS

Operator: USA

Class: CALIFORNIA

Built: 2
Active: 2

Displacement:
light: 8,706 t
standard: 9,561 t (CGN 37: 9,473 t)
full load: 10,450 t

Dimensions
Length: 181.7 m (596 ft)

Beam: 18.6 m (61 ft)
Draught: 9.6 m (31.5 ft) (sonar)

Speed: 30+ kts

Complement: 603 (44 officers)

SHIPS

CALIFORNIA (CGN 36)

Builder	Newport News Shipbuilding
Laid down	23 Jan 1970
Launched	22 Sep 1971
Commissioned	16 Feb 1974

SOUTH CAROLINA (CGN 37)

Builder	Newport News Shipbuilding
Laid down	1 Dec 1970
Launched	1 Jul 1972
Commissioned	25 Jan 1975

WEAPONS SYSTEMS

TABLE I: WEAPONS SYSTEMS SUMMARY

	CGN 36-37
Air defence	
Missile launcher	2 Mk 13 Mod 7 single-launchers
Magazines	2
Number of missiles	80 SM-1MR missiles
Anti-ship	
Missile	Harpoon
Number	8
Guns	
Main	2—127 mm (5 in) Mk 45 Mod 0
CIWS	2—20 mm/76 Vulcan
Close-range	Phalanx Mk 15
	4—12.7 mm MG
Torpedoes	
Tubes	2 twin Mk 32
Torpedoes	Honeywell Mk 46 Mod 5

SURFACE-TO-AIR MISSILES

Launchers

There are two single-arm Mk 13 missile launchers, one at either end of the ship. Each is supplied by a magazine holding 40 weapons.

Standard Missile 2 (SM-2MR)

The SM-2MR is the US Navy's standard area defence missile system. The Block II MR missile can be used for surface-to-air and surface-to-surface engagements and is 24 cm (9.45 in) longer than previous missiles. The guidance assembly incorporates fast Fourier techniques in the signal processor and it possesses a passive home-on-jam capability. The propulsion section uses the Thiokol Mk 104 dual-thrust rocket motor with ARC acting as second source. This is a more powerful motor than its predecessor and it provides substantial improvements in speed and manoeuvrability as well as a 60 per cent increase in range. Having received the 'New Threat Upgrade' both these ships have the AN/SPS-49(V)5 and AN/SPS-48E radars, and the AN/SYS-2 detector/tracker system which assesses data from each search radar to produce a single track file thus avoiding duplication. When the target is detected the WDS evaluates the data and designates the target for the missile fire-control system which then tracks and illuminates it. Each tracker/illuminator radar usually controls one missile. The WDS initiates the launch sequence and the fire-control system monitors the interception.

The SM-2 missile's course is controlled from the ship by means of an RF link until the target comes within the missile seeker's field of view. This system allows the use of the ship's search radar to provide missile launch data and by shaping the missile flight path into an energy-efficient trajectory the effective range of the system is doubled.

To assist the monitoring of the missile's flight, an AN/SYR-1 communications tracking set with phased array antenna is included in the ship fit. This receives data downlinked from the missile and transmits it to the WDS. The SYR-1 has two receivers and can receive data from many missiles by using time-sharing techniques.

Specifications

(SM-2MR)
Length: 4.72 m (15.49 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.06 m (3.47 ft)
Weight: 706.7 kg (1,558 lb)
Speed: Mach 2.5
Range: 37.75 n miles (70 km)
Altitude: 19,800 m (65,000 ft)
Guidance: Semi-active radar homing

Manufacturers/Contractors

Hughes Missile Systems Company
Raytheon Missile Systems Division.

ANTI-SHIP MISSILES

McDonnell Douglas UGM-84B Harpoon

Eight Harpoon anti-ship missile canisters are mounted in two quadruple launchers, with four pointing to either beam. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s.
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing

South Carolina *(CGN 37). Sensors and weapons in the centreline from the head of the mainmast aft are: Raytheon SPS-49(V)5 air search radar; Lockheed SPQ-9A fire control (in large dome); Two Raytheon SPG-51D fire control (for SM-2MR); Four McDonnell Douglas Harpoon launchers; United Defense 127 mm (5 in)/54 Mk 45 Mod 0 gun; Mk 13 Mod 7 launcher for SM-2MR SAM. Note also the Mk 15 Phalanx on the platform abreast the mainmast* (Giorgio Arra)

Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

ANTI-SUBMARINE MISSILES

ASROC
The ASROC launchers and magazines, previously fitted in this class, were removed in 1993.

TORPEDOES

There are two pairs of 324 mm Mk 32 fixed torpedo tubes launching Mk 46 Mod 5 torpedoes.

Specifications
Role: ASW
Homing: Active/passive
Range: 5.91 n miles (9.95 km)
Speed: 40 kts
Warhead: 44 kg (97 lb)

Manufacturer/Contractor
Honeywell.

GUNS

Mk 45 Mod 0 single 127 mm (5 in) L/54 gun mounting
Two single 127 mm Mk 45 Mod 0 guns are mounted, one forward, the second aft. The weapon fires semi-fixed ammunition with point detonating, proximity (variable time or infra-red), mechanical time and electronically set fuzes. The theoretical rate of fire is 20 rds/min and a gun crew of six is required, all below decks, of which four are ammunition handlers. The Mod 1 incorporates a number of improvements, including the ability to change the type of ammunition under remote control and electronic fuze setting.

Specifications
Calibre: 127 mm (5 in)
Length of barrel: 54 calibres
Muzzle velocity: 807.72 m/s (new barrel), 762 m/s (mid-life)
Crew: 6 (1 mount captain, 1 panel operator, 4 ammunition handlers)
Traverse: 340° at 30°/s
Elevation: −15 to +65° at 20°/s
Range:
anti-ship: 12.39 n miles (23 km)
anti-air: 15,000 m (49,000 ft)
Rate of fire: 16-20 rds/min
Ammunition weight: 31.75 kg (projectile)

Manufacturer/Contractor
United Defense, Armament Systems Division, Minneapolis, Minnesota, USA.

Hughes Mk 15 CIWS Phalanx
Two Hughes Mk 15 Phalanx close in weapons systems (CIWS) provide the innermost layer of defence against anti-ship missiles. The two mounts are situated high on the superstructure immediately abaft the foremast. Each mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n miles (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications
Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor
Hughes Missiles, Tucson, Arizona, USA.

Machine-guns
There are mountings for four 12.7 mm MGs.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES ELECTRONIC COUNTERMEASURES (ESM/ECM)

AN/SLQ-32(V)3 Sidekick ESM Suite
The SLQ-32(V)3 suite is designed to give radar warning and jamming/deception for larger ships of the US Navy. The ESM capability is the same as that of the (V)2 suite, but extra equipment racks are added in the EW room and computer memory has been increased from 64 to 80 K. The hydraulically roll-stabilised, outboard antenna assemblies are also enlarged to accommodate Band 3 transmitter antennas and electronics; two are located in the lower portion of each assembly. The AN/SLQ-32(V)3 AECM mode can be operated semi-automatically, where the operator initiates jamming against a given emitter, or automatically under computer control, where the system initiates countermeasure action as soon as a threat is identified, generating an appropriate response in the required direction, with the computer scheduling transmissions, so that multiple targets can be countered simultaneously.

Manufacturer/Contractor
Raytheon Company, Electromagnetic Systems Division, Goleta, California.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher

Four Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications

Launcher
Dimensions: 160 × 43 × 86 cm
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Rounds
Mk 182: 1,209 × 130 mm; 22.7 kg
Super Chaffstar: 1,209 × 130 mm; 20.9 kg
Super Gemini: 451 × 130 mm; 5.5 kg
Super Hiram III: 1,220 × 130 mm; 13.6 kg
Super Hiram IV: 467 × 130 mm; 3.8 kg
Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturer/Contractor

Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

AN/SLQ-25 Nixie noisemaker

One AN/SLQ-25 Nixie (Phase 1), solid-state, modular design electroacoustic countermeasures decoy system used to protect the carrier from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 487.5 m (1,600 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408.24 kg (900.2 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 94.6 cm (3.1 ft) long, 15.24 cm (6 in) in diameter and weigh 18.14 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body at a time is deployed.

Manufacturer/Contractor

Aerojet ElectroSystems, Sacramento, California, USA.

AN/SSQ-108(V)2 OUTBOARD II shipborne countermeasures detection and analysis system

The AN/SSQ-108(V)2 system (also known as OUTBOARD II) is designed to provide real-time technical and tactical intelligence data to enable the force commander to analyse enemy dispositions and intentions for Over-The-Horizon (OTH) detection and identification of surface ships for targeting purposes. The elements of AN/SSQ-108(V)2 OUTBOARD II are:

SRD-19A, which consists of a masthead VHF direction-finding group of Adcock-type arrays and 24 deck-edge antennas in three groups of eight, which are electronically switched to form receiving beams.
SLR-16A countermeasures receiver.
OK-324/SYQ System Supervisor Station (SSS), including a modification kit to upgrade it from the SSQ-108(V)1.
the SLR-23 automated narrowband acquisition system.
a local monitoring station and tactical intelligence communications.

The OK-324/SYQ SSS integrates and controls OUTBOARD sensors as well as external datalinks and communication to provide information processing and technical dissemination. The system uses hull- and mast-mounted antenna arrays. The system has been fitted in about 36 destroyers and cruisers to provide signals intelligence, early warning and OTH capabilities to surface ships that accompany each US Navy carrier force.

Manufacturer/Contractor

Lockheed Sanders, Nashua, New Hampshire, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

ACDS (CGN 37)
NTDS (CGN 36)
Link 4A
Link 11
Link 14
Link 16 (possibly)
Satcom SRR-1
WSC-3 (UHF)
USC 38 (EHF)
Tacan: URN 25

California *(CGN 36) running trials in 1973. Forward of the bridge are: Mk 16 ASROC eight-cell launcher (removed in 1993); United Defense 127 mm (5 in)/54 Mk 45 Mod 0 gun; Mk 13 Mod 7 launcher for SM-2MR SAM; AS-2865 HF discone antenna for NTDS (Navy Tactical Data System) datalink* (Newport News)

WEAPONS CONTROL

Two Mk 74 Mod 4 missile fire-control system

Mk 74 acquires, tracks and illuminates targets assigned to it by the WDS Mk 14 Mod 4 (Weapon Direction System). Following missile launch (in which it is not involved), the Mk 74 monitors the weapon and controls it until interception of the target, following which it carries out a post-launch evaluation. The system consists of a computer system, an AN/SPG-51 G/H-I/J-band radar, a Mk 73 director and associated consoles.

The computer is the Mk 152 Mod 5. The SPG-51 radar uses a G/H-band pulse Doppler technique for automatic acquisition, tracking and missile guidance. The I/J-band CW illuminator is used as a reference beam in directing missiles and is detected by the missile's reference antennas as the signal antenna locks on to the energy reflected from the target. By comparing the target-reflected energy and missile rear reference energy it is possible to home the missile. The Tartar-D radar, SPG-51C, has two independent channels each with a G/H-band tracking radar and an I/J-band illumination transmitter. The Mk 73 director is a rotating electronic structure which includes the transmitter group, the control power supply for CW injection, the power supply for the pulse Doppler system, and a radar data converter. It can traverse up to 360° while elevation limits are −30 to +83°.

Manufacturer/Contractor

Raytheon Company, Equipment Division.

Mk 86 Mod 3 gun fire-control system

The Mk 86 system assists direct and indirect naval gun fire support and also supports the engagement of both surface and air targets. Using a mainframe architecture and CMS-2 software language, it consists of a computer system, a display system and as many as three sensors, and accepts data from NTDS, the Mk 74 fire-control system and optical Target Designation Transmitters. The system uses the AN/UYK-7 32-bit computer with a memory of 256,000 words and an operating speed of 667,000 operations per second and can track 120 targets.

The primary sensors are the AN/SPQ-9A and AN/SPG-60 fire-control radars for surface and air engagements respectively, as well as a remotely operated electro-optic tracker known as the Remote Optical Sight (ROS) of which there are usually two. Another electro-optical tracker (also designated an ROS) is attached to the AN/SPG-60 antenna mounting.

AN/SPQ-9A is a high-resolution, track-while-scan, pulse compression I-band radar which provides detection and tracking facilities against surface targets at ranges between 135 m (450 ft) and 20 n miles (37 km) and limited air cover at altitudes up to 610 m (2,000 ft). The AN/SPG-60 is a four-horn amplitude-comparison monopulse I/J-band pulse Doppler radar which can acquire and track targets at ranges up to 100 n miles (185 km). The search-to-acquire capability is computer directed and the radar can accept 2D and 3D target designation co-ordinates in digital or synchro format. The Mod 3 is specially configured to control two 127 mm (5 in) guns for defence against surface and air targets and for shore bombardment and has two ROSs.

Manufacturer/Contractor

Lockheed Electronics Company, USA.

Mk 114 surface ship anti-submarine fire-control systems

The Mk 114 fire-control system is similar in function and architecture to the Mk 111 with the primary difference being the replacement of the Mk 38 Attack Console with the Mk 53 Attack Console which has the same type of display screen. In many systems a Mk 134 stabilisation computer is added to provide azimuth and elevation orders for the sonar while other systems include a Mk 143 position-keeping computer to control wire-launched torpedoes. The system is associated with the same sensors as the Mk 111 but it can also interface with the AN/SQS-26 and AN/SQR-18.

The Mk 53 Attack Console is an electromechanical analogue system and like its predecessor it consists of two major units, the attack plotter and the ballistic computer with the same functions. The ballistic computer also conducts weapon presets for the ASW torpedoes, removing the need for the Mk 264 control panel. The Mk 114 uses the Mk 33 underwater fire-control switchboard which accepts data from two Mk 19 gyrocompasses, as well as the sensors associated with the Mk 111, and there is an added Mk 134 sonar stabilisation computer. The sonar is the AN/SQS-26CX (see below).

AN/SYS-2(V)2 data fusion system

The role of the SYS is to increase the number of air and surface targets which may be detected and tracked in all types of electronic environments. The system accepts contacts from each radar, seeks potential targets, correlates the data by comparing all the sensors' returns and then produces a single file of valid tracks, while avoiding duplication. The different radar characteristics provide an overlapping volume of coverage in a variety of clutter and ECM environments which may be monitored to obtain the best possible search coverage. The data is then fed to the ship's command and weapon control systems, and accepts inputs from fire-control radars.

Each system consists of two 16-bit Paramax AN/UYK-44 computers and two display consoles. In later systems 32-bit digital microprocessors are added to improve sensor data fusion. The AN/UYK-44 is capable of 900 Kops. Supplementary processors are the Motorola 68020, the INMOS Transputer (801/5) and the Intel i860 RISC. The UYK-44 uses Ultra-16 Assembly language and Ada is planned for SYS-2. The transputer uses OCCAM software language. In most systems one computer is used to interface with the sensors and the inertial navigation system while the other supports the display consoles and interfaces with the combat direction system, and fire/weapon control systems.

In SYS-2 (V)2 one computer supports the AN/SPS-49 radar which acts as the long-range tracker while the second interfaces with the Mk 92 fire-control system and, through the preprocessor, with the AN/SPS-55 radar which acts as the medium-range tracker.

Manufacturer/Contractor
Norden Systems, Melville, New York, USA.

SONAR

The Lockheed Martin Electronic Systems Division AN/SQS-26CX is a low-frequency, hull-mounted, active/passive sonar system using a circular array which is 1.6 m (5.2 ft) high and 4.8 m (15.7 ft) in diameter with 576 transducer elements and 37 cabinets of signal processing, transmitting and display equipment.

SQS-26CX has a peak power of 100 kW and operates at 3-4 kHz. The SQS-26 operates in surface duct, bottom bounce and convergence zone modes. Surface duct mode is for shorter ranges, bottom bounce mode is for medium ranges and convergence zone mode is for longer ranges, the last two modes requiring electronic beam-steering in elevation. Reported ranges of the system are 10 n miles (18.5 km) in surface duct mode and 34.5 n miles (64 km) in convergence zone mode.

RADARS

	SPS-48E	SPS-49(V)5	SPS-67(V)2	LN-66	SPG-51D (four)	SPQ-9A	SPG-60
Manufacturer	ITT	Raytheon	Norden	Canadian Marconi	Raytheon	Lockheed	Lockheed
Role	Air search	Air search	Surface search	Navigation	Standard missile fire control	Gun fire control	Mk 86 FCS fire-control radar
Band	E/F	C/D	H (5.45-5.83 GHz)	I/J (9.3-9.4 GHz)	G/I	I/J	I/J
Beam	1.5 × 1.6°	3.3 × 9°	1.5 × 16°	2.5 × 22°	1.6°	1.3 × 3°	1.2 × 1.2°
Peak power	2,200 kW	280 kW	500 kW	75 kW	81 kW	1.2 kW	5.5 kW
Gain	38.5 dB	29 dB	30 dB	30 dB	39.5 dB	37 dB	41.5 dB
Pulsewidth	3 µs	125 µs	0.1/0.25/1 µs	1.0/0.1 µs	2.1-3.2 µs	0.3-1.6 µs	0.27/1/6 µs
PRF	1,250-2,000 pps	280 pps	2,400/1,200/750 pps	500/2,000 pps	4,100 pps	3,000 pps	25,000-35,000 pps
Scan rate	7.5/15 rpm	6/12 rpm	15 rpm	22 rpm	—	60 rpm	—

AVIATION

AVIATION FACILITIES

Flight deck

There is a helicopter flight deck at the stern, but there are no hangar, refuelling or maintenance facilities.

PROPULSION

Specifications
System: Nuclear
Main machinery: 2 General Electric PWR D2G nuclear reactors; 52 MW (70,000 hp)
Turbines: 2
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The US Navy's nuclear-propelled cruiser (CGN) fleet started with three single-ship classes — Long Beach, Bainbridge and Truxtun — all of which have now left service. The 'California' class was the first to be scheduled for series production, with *California* being authorised in FY67 and *South Carolina* in FY68. Both were nearly cancelled, as the then Secretary of Defense, Robert McNamara, considered them to be far too expensive, but Congressional pressure ensured that they were completed. A third ship was authorised in FY68, but was not built, partly because of rising costs, but also because the Virginia design promised to be more cost-effective.

DESIGNATION

These two ships were originally classified as fleet escorts (frigates), but when built were classified as 'guided missile destroyers, nuclear-powered' and given 'DLGN' pennant numbers. They were reclassified as guided missile cruisers (CGN) on 30 June 1975.

MODERNISATION

It was planned to fit Tomahawk missiles but the project was cancelled due to topweight constraints. Both have completed the New Threat Upgrade (NTU) modernisation, which included replacing the Standard SM-1MR with the SM-2MR version, upgrading the Mk 74 MFCS and SPG-51D radars, replacing the SPS-40B radar by SPS 49, upgrading the SPS-48 radar, and installing the Mk 14 weapon direction system and the SYS(V)2 IADT.

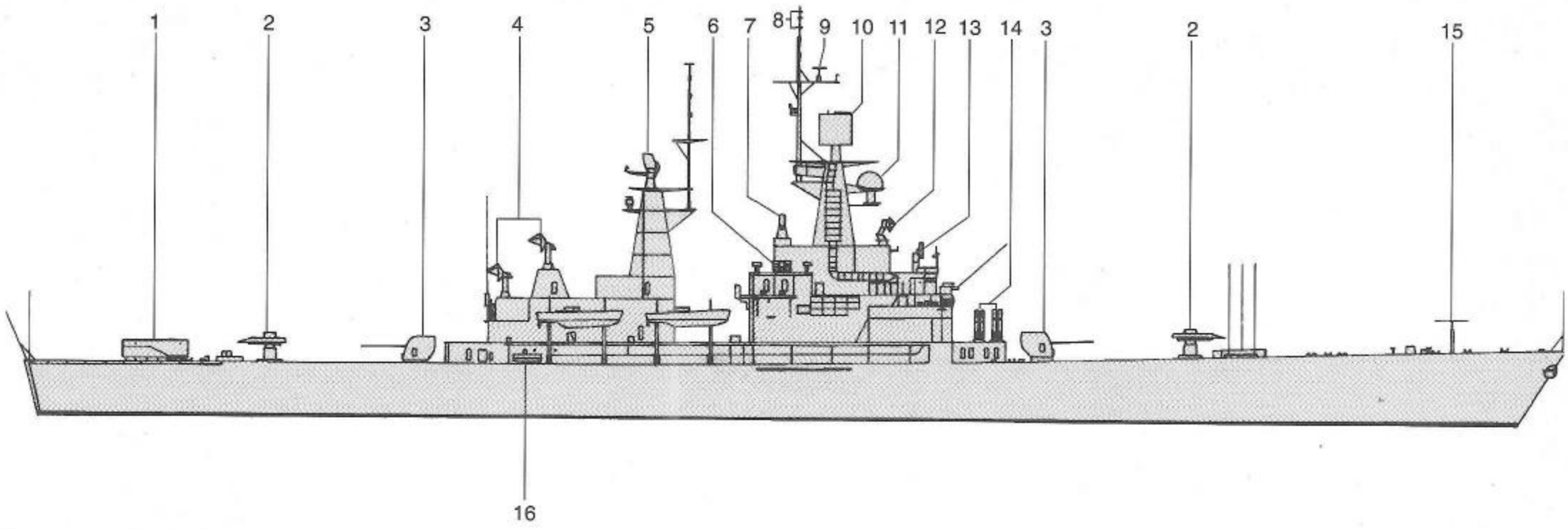
Harpoon missiles have also been installed, in two widely separated quadruple sets; one launcher is amidships facing to starboard and the second aft, just forward of the gun, facing to port.

OPERATIONAL

The removal of ASROC, the absence of a LAMPS system and the lack of any other ASW weapons than the four torpedo tubes, gives these two ships a very limited ASW capability.

One serves in the Pacific Fleet, the other in the Atlantic Fleet and both are scheduled to pay-off in 1998/99.

VIRGINIA



Arkansas (Ian Sturton)
1 *Mk 143 armoured box launchers (two, each with four Tomahawk missiles)* **2** *Mk 26 twin arm launcher (for SM-2MR SAM)* **3** *United Defense 127 mm (5 in)* **4** *SPG-51D radar illuminators (for SM-2MR)* **5** *Raytheon SPS-49(V)5 radar* **6** *Raytheon SLQ-32(V)3 ESM array* **7** *Mk 15 20 mm Vulcan Phalanx CIWS* **8** *Sigint antennas* **9** *Cardion SPS-55 surface search radar* **10** *ITT SPS-48E 3D air search radar* **11** *SPQ-9A fire-control radar (for 127 mm guns)* **12** *SPG-600 fire-control radar (for missiles and guns)* **13** *Antenna for WSC-3 SATCOM system* **14** *Eight Harpoon anti-ship missiles* **15** *NTDS antenna* **16** *Mk 32 triple 324 mm ASW torpedo launcher*

GENERAL SPECIFICATIONS

Operator: USA
Type: Cruiser, guided missile, nuclear-powered (CGN)

Class: VIRGINIA

Built: 4
Active: 2

Displacement:
light: 8,623 t
full load: 11,300 t

Dimensions
Length: 178.3 m (585.0 ft)
Beam: 19.2 m (63.0 ft)
Draught: 9.6 m (31.5 ft) (sonar)

Speed: 30+ kts

Complement: 558-624 (38-45 officers)

SHIPS

MISSISSIPPI (CGN 40)

Builder	Newport News Shipbuilding, Newport News, USA
Laid down	22 Feb 1975
Launched	31 Jul 1976
Commissioned	5 Aug 1978

ARKANSAS (CGN 41)

Builder	Newport News Shipbuilding, Newport News, USA
Laid down	17 Jan 1977
Launched	21 Oct 1978
Commissioned	18 Oct 1980

WEAPONS SYSTEMS

WEAPONS SYSTEMS SUMMARY

CGN 40-41	
Air defence	
Missile launcher	2 Mk 26 twin-arm launchers
Magazines	2
Missiles	Each 34 SM-2MR Block 2 missiles
Land-attack	
Missile	Tomahawk
Number	8
Anti-ship	
Missile	Harpoon
Number	8
Guns	
Main	2—127 mm (5 in) Mk 45
CIWS	2—20 mm/76 Vulcan Phalanx Mk 15
Close-range	4—12.7 mm MG
Torpedoes	
Tubes	2 triple Mk 32
Torpedoes	36 Honeywell Mk 46 Mod 5

SURFACE-TO-SURFACE MISSILES

BGM-109 Tomahawk

There are two quad launchers on the after deck. These ships can carry any version of Tomahawk, two of which are for land-attack missions, one with a conventional HE warhead (BGM-109C Tomahawk Land Attack Missile-Conventional (TLAM-C)) and the other with submunitions (BGM-109D Tomahawk Land Attack Missile-D (TLAM-D)). The third type is the BGM-109B Tomahawk Anti-Ship Missile (TASM), which also has a conventional HE warhead. A fourth version, BGM-109A Tomahawk Land Attack Missile-Nuclear (TLAM-N), has been removed from ships at sea, but is retained in reserve ashore and the ships could quickly be recertified for TLAM-N in an emergency.

The major subtype now in service is the Block II, although the Block III has been in production since 1993 and Block II missiles are being progressively brought up to the new standard. The missile is launched using a rocket booster until the turbofan engine takes over and the booster is jettisoned.

BGM-109A uses inertial navigation with terrain contour matching (Tercom), while BGM-109B uses inertial plus active radar terminal guidance, and BGM-109C/D inertial and Tercom mid-course guidance with Digital Scene Matching Area Correlation (DSMAC) for terminal guidance. Tercom stores digital terrain profile map information in the missile before launch, which is compared with radar altimeter measurements of ground elevations below the missile during a set number of sections en route to the target. The Block III upgrade programme includes a Global Positioning System (GPS) receiver to supplement or replace the Tercom system. In the terminal phase, DSMAC compares a stored digital representation of the target area with the scene viewed below the missile by a TV camera. This latter system is claimed to be extremely accurate for attacking land targets, with a circular error probable (CEP) of 10 m (32.8 ft) being reported. Both the BGM-109C and D versions have a programmable terminal dive attack mode option.

The BGM-109A is fitted with a W80 135 kg (298 lb) nuclear warhead, while the BGM-109B/C have 454 kg (1,000 lb) unitary HE warheads taken from old Bullpup B missiles. The BGM-109D has 166 combined effects BLU-97B bomblets, each weighing 1.5 kg (3.3 lb) which can be dispensed in groups against up to four separate targets.

Block III missiles have a more powerful and more fuel-efficient turbofan engine, which, coupled with increased fuel capacity, results in a range increase of at least 30 per cent. The BGM-109C Block 3 missiles have a smaller WDU-36B 320 kg (700 lb) warhead carrying a unitary HE charge with a selectable fuze delay to increase warhead penetration before detonation.

Specifications

Designation	BGM-109B (Note 1)	BGM-109C Block II	BGM-109D Block II	Block III
Mission	Tomahawk anti-ship missile (TASM)	Tomahawk land-attack missile - conventional (TLAM-C)	Tomahawk land-attack missile - D (TLAM-D)	
Airframe standard	Block II	Block II	Block II	Block III
Length	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)
Diameter	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)
Wing span	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)
Launch weight	1,452 kg (3,201 lb)	1,452 kg (3,201 lb)	1,452 kg (3,201 lb)	n/k
Warheads	454 kg HE (1,000 lb)	454 kg HE (1,000 lb)	166 bomblets	320 kg (705 lb)
Range	240 n miles (450 km)	490-700 n miles (900-1,300 km)	490 n miles (900 km)	690-1,000 n miles (1,285-1,857 km)
Accuracy — circular error probable (cep)	n/a	10 m (33 ft)	10 m (33 ft)	10 m (33 ft)
Speed	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)
In-service date	1983	1983	1989	1993
Engine	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR402 turbofan (335 kg thrust)
Number currently on order	593	1,486	1,157	

Notes
1. BGM-109A (TLAM-N) is not listed as it is not deployed in operational ships, but it should be noted that it remains in reserve ashore

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA (prime).
McDonnell Douglas Missile Systems, St Louis, Missouri, USA (second source).

McDonnell Douglas UGM-84B Harpoon
Eight Harpoon anti-ship missile canisters are mounted immediately forward of the bridge. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Texas *(CGN 39) shows the two armoured box launchers mounted at the stern for Tomahawk land-attack missiles. Each box contains four missiles* (H & L van Ginderen Collection)

Specifications
(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 kg)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

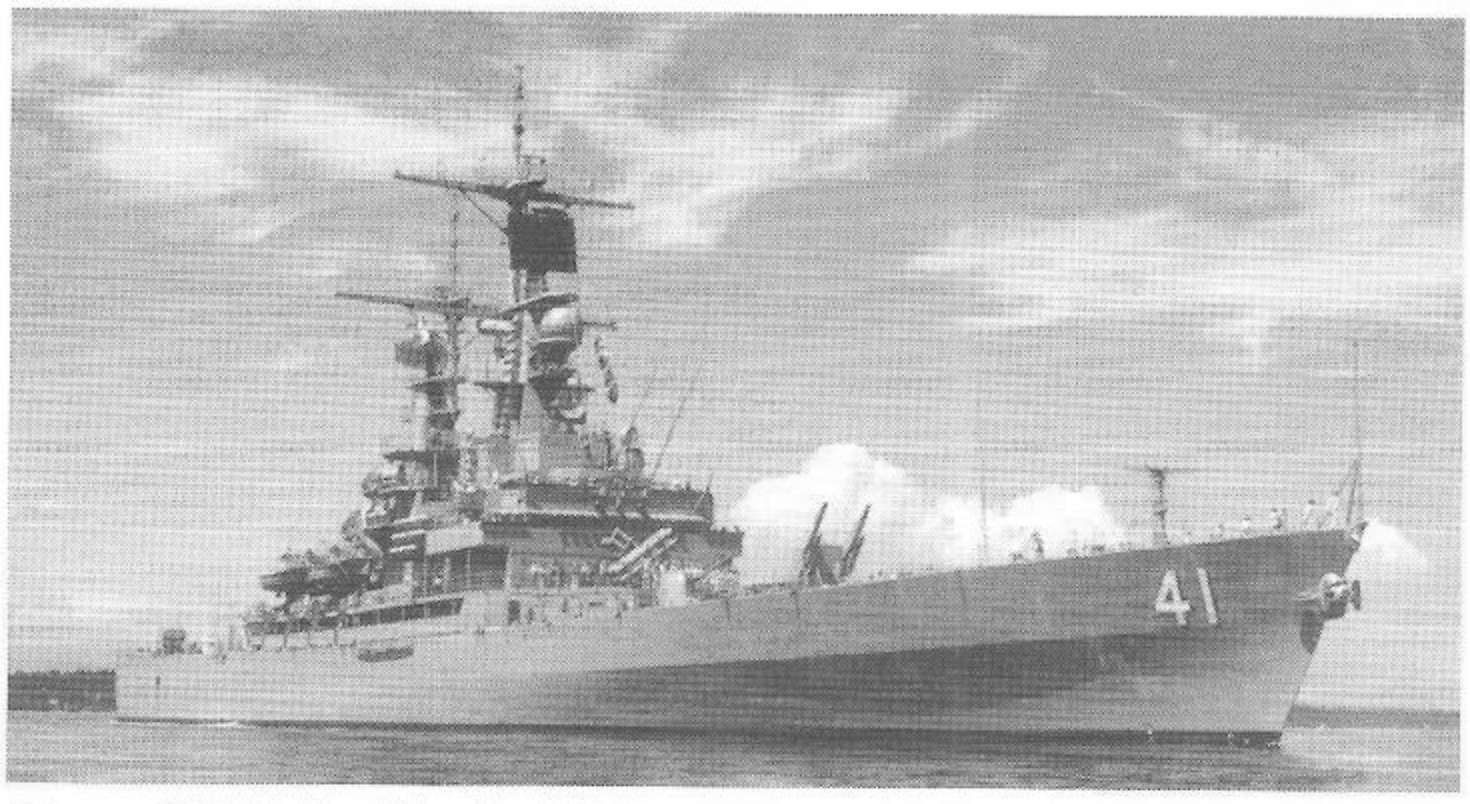
Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

SURFACE-TO-AIR MISSILES

Launchers
There are 2 twin GMLS Mk 26 missile launchers supplied by magazines holding a total of 68 weapons. The ASROC missile was withdrawn in FY94.

Standard Missile 2 (SM-2MR)
The SM-2MR is the US Navy's standard area defence missile system. The Block II MR missile can be used for surface-to-air and surface-to-surface engagements and is 24 cm (9.45 in) longer than previous missiles. The guidance assembly incorporates fast Fourier techniques in the signal processor and it possesses a passive home-on-jam capability. The propulsion section uses the Thiokol Mk 104 dual-thrust rocket motor with ARC acting as second source. This is a more powerful motor than its predecessor and it provides substantial improvements in speed and manoeuvrability as well as a 60 per cent increase in range. Long-range (300 km plus) air search radars associated with the Standard Missile are the AN/SPS-40, AN/SPS-48 and the AN/SPS-49. Having received the 'New Threat Upgrade' both these ships have their radars supplemented by the AN/SYS-2 detector/tracker system which assesses data from each search radar to produce a single track file thus avoiding duplication. When the target is detected, the WDS evaluates the data and designates the target for the missile fire-control system which then tracks and illuminates it. Each tracker/illuminator radar usually controls one missile. The WDS initiates the launch sequence and the fire-control system monitors the interception.

The SM-2 missile's course is controlled from the ship by means of an RF link until the target comes within the missile seeker's field of view. This system allows the



Arkansas *(CGN 41). The ability of the Mk 26 launcher to handle both Standard SAMs and ASROC ASW missiles meant that the separate ASROC launcher could be dispensed with. This meant that the 'Virginia' class hull could be 3.35 m (11 ft) shorter than the 'California' class* (H & L van Ginderen Collection)

use of the ship's search radar to provide missile launch data and by shaping the missile flight path into an energy-efficient trajectory the effective range of the system is doubled.

To assist the monitoring of the missile's flight, an AN/SYR-1 communications tracking set with phased array antenna is included in the ship fit. This receives data downlinked from the missile and transmits it to the WDS. The SYR-1 has two receivers and can receive data from many missiles by using time-sharing techniques.

Specifications
(SM-2MR)
Length: 4.72 m (15.49 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.06 m (3.47 ft)
Weight: 706.7 kg (1,558 lb)
Speed: Mach 2.5
Range: 37.75 n miles (70 km)
Altitude: 19,800 m (65,000 ft)
Guidance: Semi-active radar homing

Manufacturers/Contractors
Hughes Missile Systems Company.
Raytheon Missile Systems Division.

TORPEDOES

There are six 324 mm Mk 32 (two triple) tubes on the weather deck near the after end of the superstructure. A mix of Mk 46 Mod 5 and Alliant/Westinghouse Mk 50 torpedoes is carried.

	Honeywell Mk 45 Mod 5	Mk 50
Maker	Honeywell	Alliant
Role	ASW	ASW
Homing	active/passive	active/passive
Range	5.91 n miles (9.95 km)	8.1 n miles (15 km)
Speed	40 kts	50 kts
Warhead	44 kg (97 lb)	45 kg (99.2 lb)

GUNS

Mk 45 Mod 0 single 127 mm (5 in) L/54 gun mounting
Two single Mk 45 Mod 0 guns are mounted, one forward, the second aft. The weapon fires semi-fixed ammunition with point detonating, proximity (variable time or infra-red), mechanical time and electronically set fuzes. The theoretical rate of fire is 20 rds/min and a gun crew of six is required, all below decks, of which four are ammunition handlers. The Mod 1 incorporates a number of improvements, including the ability to change the type of ammunition under remote control and electronic fuze setting.

Specifications
Calibre: 127 mm (5 in)
Length of barrel: 54 calibres
Muzzle velocity: 807.72 m/s (new barrel), 762 m/s (mid-life)
Crew: 6 (1 mount captain, 1 panel operator, 4 ammunition handlers)
Traverse: 340° at 30°/s
Elevation: −15 to +65° at 20°/s
Range:
anti-ship: 12.39 n miles (23 km)
anti-air: 15,000 m (49,000 ft)
Rate of fire: 16-20 rds/min
Ammunition weight: 31.75 kg (projectile)

Manufacturer/Contractor
United Defense, Armament Systems Division, Minneapolis, Minnesota, USA

Hughes Mk 15 CIWS Phalanx
Two Hughes Mk 15 Phalanx close in weapons systems (CIWS) provide the innermost layer of defence against anti-ship missiles. The two mounts are situated high on the superstructure immediately abaft the foremast. Each mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n miles (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications
Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor
Hughes Missile, Tucson, Arizona, USA (missiles).

Machine-guns
There are mountings for four 12.7 mm MGs.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES (ECM)

AN/SLQ-32(V)3 Sidekick ESM Suite
The SLQ-32(V)3 suite is designed to give radar warning and jamming/deception for larger ships of the US Navy. The ESM capability is the same as that of the (V)2 suite, but extra equipment racks are added in the EW room and computer memory has been increased from 64 to 80 K. The hydraulically roll-stabilised, outboard antenna assemblies are also enlarged to accommodate Band 3 transmitter antennas and electronics; two are located in the lower portion of each assembly. The AN/SLQ-32(V)3 AECM mode can be operated semi-automatically, where the operator initiates jamming against a given emitter, or automatically under computer control, where the system initiates countermeasure action as soon as a threat is identified, generating an appropriate response in the required direction, with the computer scheduling transmissions, so that multiple targets can be countered simultaneously.

Manufacturer/Contractor
Raytheon Company, Electromagnetic Systems Division, Goleta, California.

ELECTRONIC COUNTERMEASURES (ECM)

AN/SLQ-25 Nixie noisemaker
One AN/SLQ-25 Nixie (Phase 1), solid-state, modular design electroacoustic countermeasures decoy system used to protect the carrier from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 487.5 m (1,600 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408.24 kg (900.2 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 94.6 cm (3.1 ft) long, 15.24 cm (6 in) in diameter and weigh 18.14 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body at a time is deployed.

Manufacturer/Contractor
Aerojet ElectroSystems, Sacramento, California, USA.

AN/SSQ-108(V)2 OUTBOARD II shipborne countermeasures detection and analysis system
The AN/SSQ-108(V)2 system (also known as OUTBOARD II) is designed to provide real-time technical and tactical intelligence data to enable the force commander to analyse enemy dispositions and intentions for Over-The-Horizon (OTH) detection and identification of surface ships for targeting purposes. The elements of AN/SSQ-108(V)2 OUTBOARD II are:

SRD-19A, which consists of a masthead VHF direction-finding group of Adcock-type arrays and 24 deck-edge antennas in three groups of eight, which

are electronically switched to form receiving beams.
SLR-16A countermeasures receiver.
OK-324/SYQ System Supervisor Station (SSS), including a modification kit to upgrade it from the SSQ-108(V)1.
the SLR-23 automated narrowband acquisition system.
a local monitoring station and tactical intelligence communications.

The OK-324/SYQ SSS integrates and controls OUTBOARD sensors as well as external datalinks and communication to provide information processing and technical dissemination. The system uses hull- and mast-mounted antenna arrays. The system has been fitted in about 36 destroyers and cruisers to provide signals intelligence, early warning and OTH capabilities to surface ships that accompany each US Navy carrier force.

Manufacturer/Contractor
Lockheed Sanders Inc, Nashua, New Hampshire, USA.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher
Four Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications
Launcher
Dimensions: 160 × 43 × 86 cm
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Rounds
Mk 182: 1,209 × 130 mm; 22.7 kg
Super Chaffstar: 1,209 × 130 mm; 20.9 kg
Super Gemini: 451 × 130 mm; 5.5 kg
Super Hiram III: 1,220 × 130 mm; 13.6 kg
Super Hiram IV: 467 × 130 mm; 3.8 kg
Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturers/Contractors
Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

ACDS (CGN 41)
NTDS (CGN 40)
Link 4A
Link 11
Link 14
Link 16
Satcom SRR-1
WSC-3 (UHF)
USC 38 (EHF)
JMCIS being fitted
Tacan: URN 25
IFF: Mk XII AIMS UPX 29

WEAPONS CONTROL

Mk 74 Mod 4 missile fire-control system
Mk 74 acquires, tracks and illuminates targets assigned to it by the WDS Mk 14 Mod 4 (Weapon Direction System). Following missile launch (in which it is not involved), the Mk 74 monitors the weapon and controls it until interception of the target, following which it carries out a post-launch evaluation. The system consists of a computer system, an AN/SPG-51 G/H-I/J-band radar, a Mk 73 director and associated consoles.

The computer is the Mk 152 Mod 5. The SPG-51 radar uses a G/H-band pulse Doppler technique for automatic acquisition, tracking and missile guidance. The I/J-band CW illuminator is used as a reference beam in directing missiles and is detected by the missile's reference antennas as the signal antenna locks on to the energy reflected from the target. By comparing the target-reflected energy and missile rear reference energy it is possible to home the missile. The Tartar-D radar, SPG-51C, has two independent channels each with a G/H-band tracking radar and an I/J-band illumination transmitter. The Mk 73 director is a rotating electronic structure which includes the transmitter group, the control power supply for CW injection, the power supply for the pulse Doppler system, and a radar data converter. It can traverse up to 360° while elevation limits are −30 to +83°.

Manufacturer/Contractor
Raytheon Company, Equipment Division, Marlborough, Massachusetts, USA.

Mk 116 Mod 1 anti-submarine fire-control system
The Mk 116 Underwater Fire-Control System is designed to provide tactical data processing, contact management, target engagement processing and weapon fire control and consists of two elements: the Computer Processing Subsystem (CPS) and the Weapon Control and Setting Subsystem (WCSS). Data are also received from external sensors and distributed around the system by an integral switchboard or data converter.

The CPS provides displays of tactical data, computes and stores track data, calculates weapon control firing solutions for selected targets and generates weapon recommendations and launcher orders. Most systems are based upon NTDS hardware with an AN/UYK-7 computer with a memory of 256,000 32-bit words and an optimum processing power of 667,000 operations/s. The newest systems have two

Virginia *(CGN 38) running trials in 1976. The apparently bare foredeck, with only a single gun and a single missile launcher gave rise to criticism at the time that US warships were ill-equipped compared with Soviet ships, whose decks were cluttered with weapons. This overlooked the fact that the Mk 26 launcher could handle both SM-2 and ASROC missiles* (Newport News Shipbuilding)

AN/UYK-43B computers, each of which has two Central Processing Units (CPU) with a memory of 2,560,000 words and an optimum processing power of 3,002,000 operations/s. Both systems use the US Navy's own CMS-2 language.

The WCSS is basically the same in all the Mk 116 systems, except for the Mod 7, which is the version used in CG 56-73. It consists of the Mk 329 weapon control panel which selects the fire-control mode, the sensor-weapon pairing, weapon and launcher, torpedo presetting and then launches the weapon. The external sensors all include an electromagnetic log and the Type F wind indicator. The other sensors and the data distribution unit are tabulated alongside.

The prime sensor is the bow-mounted, low-frequency AN/SQS-53 active/passive sonar which is produced by the General Electric Company's Electronic Systems Division (SQS-53A)

Manufacturer/Contractor
Loral Librascope, Glendale, California, USA.

Mk 86 Mod 5 gun fire-control system

There is one Mk 86 Mod 5 GFCS for the forward missile channel and gun fire control. The Mk 86 system assists direct and indirect naval gun fire support and also supports the engagement of both surface and air targets. Using a mainframe architecture and CMS-2 software language, it consists of a computer system, a display system and as many as three sensors, and accepts data from NTDS, the Mk 74 fire-control system and optical Target Designation Transmitters. The system uses the AN/UYK-7 32-bit computer with a memory of 256,000 words and an operating speed of 667,000 operations/s and can track 120 targets.

The primary sensors are the AN/SPQ-9A and AN/SPG-60 fire-control radars for surface and air engagements respectively, as well as a remotely operated electro-optic tracker known as the Remote Optical Sight (ROS) of which there are usually two. Another electro-optical tracker (also designated an ROS) is attached to the AN/SPG-60 antenna mounting.

AN/SPQ-9 is a high-resolution, track-while-scan, pulse compression I-band radar which provides detection and tracking facilities against surface targets at ranges between 135 m (443 ft) and 20 n miles (37 km) and limited air cover at altitudes up to 610 m (2,000 ft). The AN/SPG-60 is a four-horn amplitude-comparison monopulse I/J-band pulse Doppler radar which can acquire and track targets at ranges up to 100 n miles (185 km). The search-to-acquire capability is computer directed and the radar can accept 2D and 3D target designation co-ordinates in digital or synchro format. The Mod 3 is specially configured to control two 127 mm (5 in) guns for defence against surface and air targets and for shore bombardment and has two ROSs.

Manufacturer/Contractor
Lockheed Electronics Company Inc, Nashua, New Hampshire, USA.

AN/SYS-2(V)2 data fusion system

The role of the SYS is to increase the number of air and surface targets which may be detected and tracked in all types of electronic environments. The system accepts contacts from each radar, seeks potential targets, correlates the data by comparing all the sensors' returns and then produces a single file of valid tracks, while avoiding duplication. The different radar characteristics provide an overlapping volume of coverage in a variety of clutter and ECM environments which may be monitored to obtain the best possible search coverage. The data is then fed to the ship's command and weapon control systems, and accepts inputs from fire-control radars.

Each system consists of two 16-bit Paramax AN/UYK-44 computers and two display consoles. In later systems 32-bit digital microprocessors are added to improve sensor data fusion. The AN/UYK-44 is capable of 900 Kops. Supplementary processors are the Motorola 68020, the INMOS Transputer (801/5) and the Intel i860 RISC. The UYK-44 uses Ultra-16 Assembly language and Ada is planned for SYS-2. The transputer uses OCCAM software language. In most systems one computer is used to interface with the sensors and the inertial navigation system while the other supports the display consoles and interfaces with the combat direction system, and fire/weapon control systems.

In SYS-2 (V)2 one computer supports the AN/SPS-49 radar which acts as the long-range tracker while the second interfaces with the Mk 92 fire-control system and, through the preprocessor, with the AN/SPS-55 radar which acts as the medium-range tracker.

Manufacturer/Contractor
Norden Systems, Melville, New York, USA.

SONAR

AN/SQS-53A

The basic sensor is the AN/SQS-53A bow-mounted, low-frequency, active/passive sonar. The array is cylindrical, 1.6 m (5.24 ft) high and 4.8 m (15.75 ft) in diameter, with 576 transducers, with a power requirement of some 65 kW. Active transmitting frequency is estimated to be about 3 kHz with a peak frequency of 192 kHz. There are three active modes: surface duct, bottom bounce and convergence zone. Estimated range is in the region of 10 n miles (18.5 km) in surface duct mode and up to 34.5 n miles (64 km) in convergence zone mode. Compared to its predecessor, SQS-26, SQS-53A has greater passive detection range, the ship is able to operate at higher speeds and the new system also gives the ship a multiple target tracking capability. SQS-53A is digital.

Manufacturer/Contractor
General Electric Company, Electronic Systems Division (SQS-53A).

RADARS

	SPS 48E	SPS-49(V)5	SPS-55	SPS-67(V)2	SPS-64(V)9	SPG-510	SPQ-9A
Manufacturer	ITT	Raytheon	Cardion	Norden	Raytheon	Raytheon	
Role	Air search	Air search	Surface search	Surface search	Navigation	Fire control	Search/track for GFCS Mk 86
Band	E/F	C/D	I/J (8-20 GHz)	H (5.45-5.83 GHz)	I/J (9.3-9.4 GHz)	H/I	H/I
Beam	1.5 × 1.6°	3.3 × 9°	1.5 × 20°	1.5 × 16°	1.9 × 22°	Track: 1.6° Illuminate: 0.9°	1.35 × 3°
Peak power	2,200 kW	280 kW	130 kW	500 kW	20 kW	Track: 81 kW Illuminate: 5 kW	1.2 kW
Gain	38.5 dB	29 dB	31 dB	30 dB	28 dB	Track: 39.5 dB Illuminate: 45 dB	37 dB
Pulsewidth	3 µs	125 µs	1/12 µs	0.1/0.25/1 µs	0.06/0.5/1.0 µs	Track: 2.1 to 3.2 µs	0.3 to 11 µs
PRF	1,250-2,000 pps	280 pps	750/2,250 pps	2,400/1,200/750 pps	3,600/1,800/900 pps	Surface: 4.1 kHz Air: 9.5 to 16.7 kHz	3,000 pps
Scan rate	7.5/15 rpm	6/12 rpm	16 rpm	15 rpm	33 rpm		60 rpm

PROPULSION

Specifications
System: Nuclear
Main machinery: 2 General Electric D2G pressurised water reactors; 2 turbines; 52 MW (70,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The US Navy's original plans were to have eleven ships of this class, but this was cut back to five, although, in the event, only four were built, being authorised in FY70 *(Virginia),* FY71 *(Texas),* FY72 *(Mississippi)* and FY75 *(Arkansas),* with authorisation for the fifth being withdrawn in FY76. They are principally intended to be anti-air warfare (AAW) escorts for nuclear-powered aircraft carrier (CVN) groups. They were originally classified as guided missile destroyers (DLGN), but were redesignated guided missile cruisers (CGN) on 30 June 1975.

Mississippi *(CGN 40) is one of the two surviving 'Virginia' class nuclear-powered cruisers and is due to leave the service in about 1998* (H & L van Ginderen Collection)

DESIGN

The principal differences between the 'Virginia' class and its predecessors, the 'California' class, are the provision of improvements to the anti-air warfare capability, electronic warfare equipment, and anti-submarine fire-control system. The use of the twin-arm Mk 26 missile launcher, which can handle both Standard SM-1 SAMs and ASROC missiles, meant that the separate ASROC launcher could be dispensed with, enabling the 'Virginia' class to be 3.35 m (11 ft) shorter than the Californias.

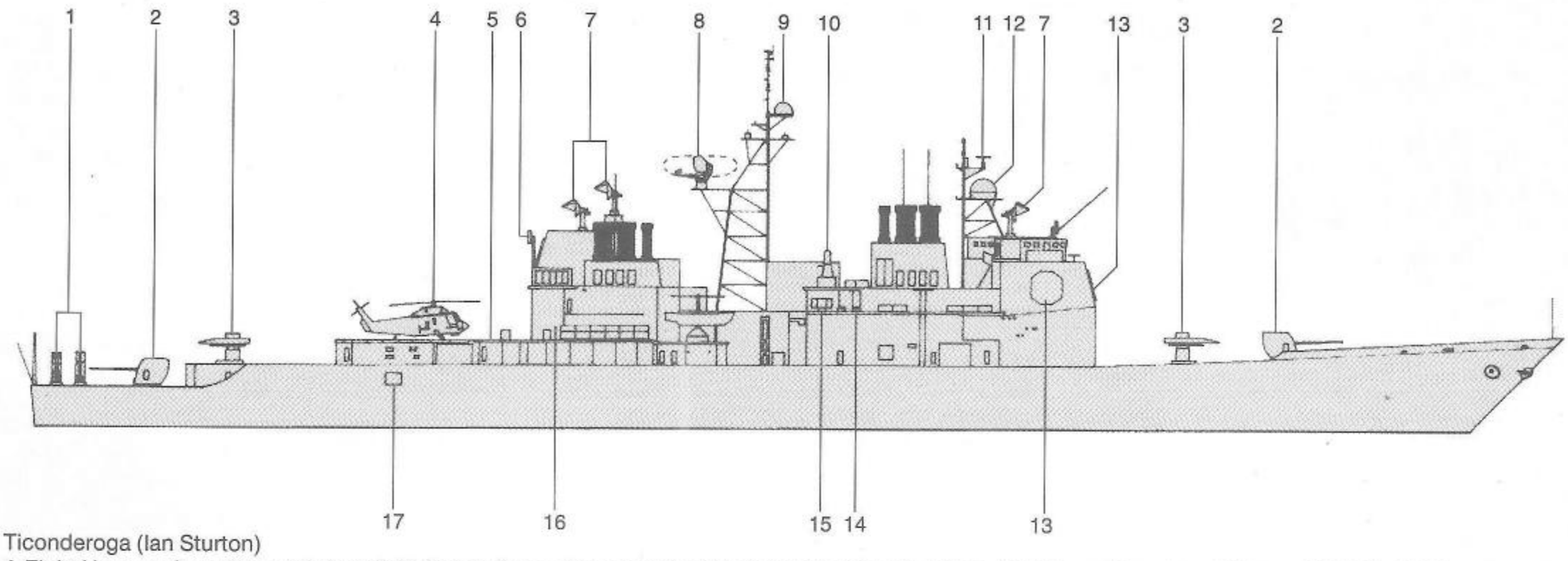
MODERNISATION

The original Standard SM-1MR SAMs were replaced by SM-2MR in FY88, using Block II missiles to counter current and projected anti-ship cruise missile threats at extended ranges in the presence of severe enemy electronic countermeasures. Tomahawk missile systems have been installed in two armoured boxes on the former flight deck, thus removing the helicopter capability. Both ships have completed New Threat Upgrade (NTU), which includes upgrading the Mk 74 MFCS and SPG 51D radars, improving the Mk 26 launchers, replacing SPS 40B radar by Raytheon SPS 49 and improving SPS 48, plus IADT SYS-2(V)2 (Integrated Automatic Detection and Track).

OPERATIONAL

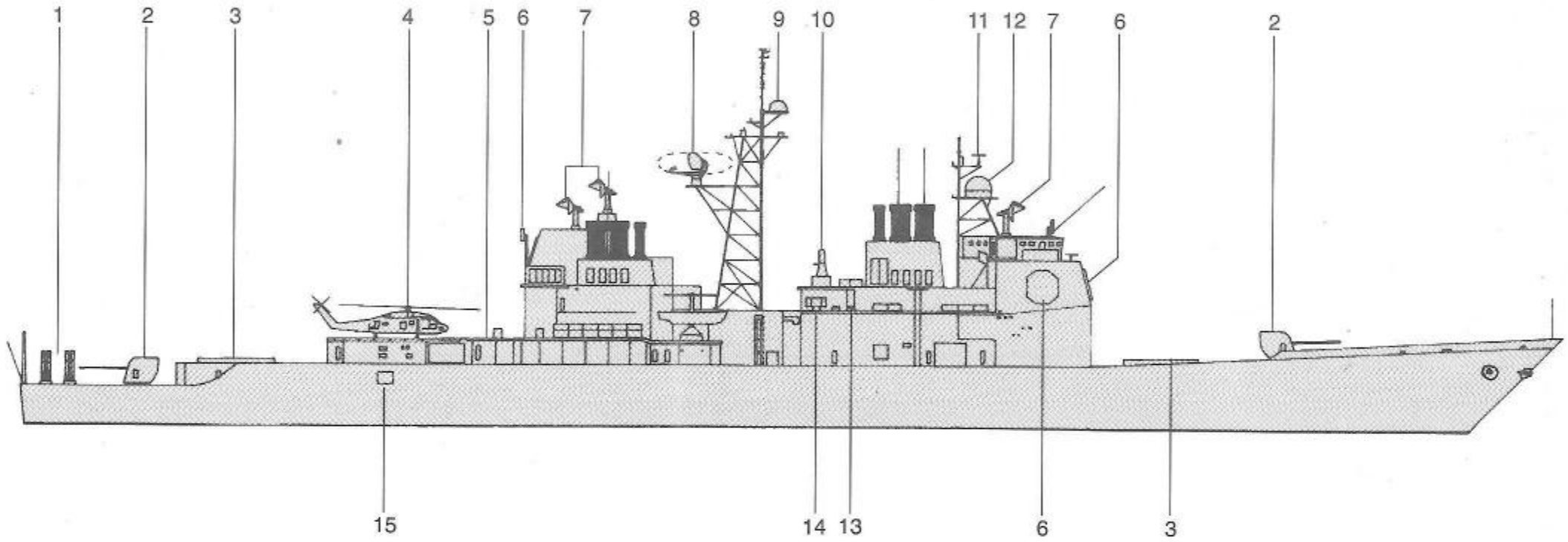
To save money on refuelling (replacing the nuclear core), *Texas* was paid off in 1993, and *Virginia* in February 1994.

TICONDEROGA (AEGIS)



Ticonderoga (Ian Sturton)

1 *Eight Harpoon launcher-containers* **2** *United Defense 127 mm (5 in)/54 Mk 45 Mod 0* **3** *Mk 26 Mod 5 twin-arm launcher* **4** *Kaman SH-2G LAMPS-I helicopter* **5** *Flight deck* **6** *SPY-1A planar array (1 facing astern, 1 to port)* **7** *Raytheon SPG-62* **8** *Raytheon SPS-49(V)7* **9** *SQQ-28 (LAMPS datalink)* **10** *Mk 15 20 mm CIWS* **11** *ISC Cardion SPS 55 (surface search radar)* **12** *Lockheed SPQ-9A (fire-control radar)* **13** *SPY-1A planar array* **14** *Mk 36 SRBOC decoy launcher* **15** *Raytheon SLQ-32(V)3* **16** *Hangar* **17** *Triple Mk 32 324 mm torpedo tubes*



Bunker Hill (Ian Sturton)

1 *Harpoon* **2** *United Defense 127 mm (5 in) Mod 1* **3** *Mk 41 Mod 0 vertical launcher (61 missiles)* **4** *Sikorsky SH-60B LAMPS III* **5** *Flight deck* **6** *SPY-1A (one facing astern, one to port)* **7** *Raytheon SPG-62* **8** *Raytheon SPS-49(V)7* **9** *SQQ 28 (LAMPS data link)* **10** *Mk 15 20 mm Vulcan Phalanx CIWS* **11** *ISC Cardion SPS 55* **12** *Lockheed SQQ 9A* **13** *Mk 36 SRBOC decoy launcher* **14** *Raytheon SLQ-32(V)3* **15** *Triple Mk 32 324 mm torpedo tubes*

GENERAL SPECIFICATIONS

Operator: USA
Type: Cruiser, guided missile (CG)

Class: TICONDEROGA

Built: 27
Active: 27

Displacement:
light: 7,015 t
full load: CG 47-48 9,590 t; CG 49-51 9,407 t
remainder: 9,466 t

Dimensions
Length: 172.8 m (567 ft)
Beam: 16.8 m (55 ft)

Draught: 9.5 m (31 ft)

Speed: 30+ kts
Range: 6,000 n miles at 20 kts

Complement: 358 (24 officers); accommodation for 405 total

SHIPS

TICONDEROGA (CG 47 (ex-DDG 47))
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 21 Jan 1980
Launched 25 Apr 1981
Commissioned 22 Jan 1983

YORKTOWN (CG 48)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 19 Oct 1981
Launched 17 Jan 1983
Commissioned 4 Jul 1984

VINCENNES (CG 49)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 20 Oct 1982
Launched 14 Jan 1984
Commissioned 6 Jul 1985

VALLEY FORGE (CG 50)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 14 Apr 1983
Launched 23 Jun 1984
Commissioned 18 Jan 1986

THOMAS S GATES (CG 51)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 31 Aug 1984
Launched 14 Dec 1985
Commissioned 22 Aug 1987

BUNKER HILL (CG 52)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 11 Jan 1984
Launched 11 Mar 1985
Commissioned 20 Sep 1986

MOBILE BAY (CG 53)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 6 Jun 1984
Launched 22 Aug 1985
Commissioned 21 Feb 1987

ANTIETAM (CG 54)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 15 Nov 1984
Launched 14 Feb 1986
Commissioned 6 Jun 1987

LEYTE GULF (CG 55)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 18 Mar 1985
Launched 20 Jun 1986
Commissioned 26 Sep 1987

SAN JACINTO (CG 56)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 24 Jul 1985
Launched 14 Nov 1986
Commissioned 23 Jan 1988

LAKE CHAMPLAIN (CG 57)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 3 Mar 1986
Launched 3 Apr 1987
Commissioned 12 Aug 1988

PHILIPPINE SEA (CG 58)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 8 May 1986
Launched 12 Jul 1987
Commissioned 18 Mar 1989

PRINCETON (CG 59)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 15 Oct 1986
Launched 2 Oct 1987
Commissioned 11 Feb 1989

NORMANDY (CG 60)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 7 Apr 1987
Launched 19 Mar 1988
Commissioned 9 Dec 1989

MONTEREY (CG 61)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 19 Aug 1987
Launched 23 Oct 1988
Commissioned 16 Jun 1990

CHANCELLORSVILLE (CG 62)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 24 Jun 1987
Launched 15 Jul 1988
Commissioned 4 Nov 1989

COWPENS (CG 63)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 23 Dec 1987
Launched 11 Mar 1989
Commissioned 9 Mar 1991

GETTYSBURG (CG 64)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 17 Aug 1988
Launched 22 Jul 1989
Commissioned 22 Jun 1991

CHOSIN (CG 65)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 22 Jul 1988
Launched 1 Sep 1989
Commissioned 12 Jan 1991

HUE CITY (CG 66)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 20 Feb 1989
Launched 1 Jun 1990
Commissioned 14 Sep 1991

SHILOH (CG 67)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 1 Aug 1989
Launched 8 Sep 1990
Commissioned 2 Jul 1992

ANZIO (CG 68)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 21 Aug 1989
Launched 2 Nov 1990
Commissioned 2 May 1992

VICKSBURG (CG 69)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 30 May 1990
Launched 2 Aug 1991
Commissioned 14 Nov 1992

LAKE ERIE (CG 70)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 6 Mar 1990
Launched 13 Jul 1991
Commissioned 24 Jul 1993

CAPE ST GEORGE (CG 71)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 19 Nov 1990
Launched 10 Jan 1992
Commissioned 12 Jun 1993

VELLA GULF (CG 72)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 22 Apr 1991
Launched 13 Jun 1992
Commissioned 18 Sep 1993

PORT ROYAL (CG 73)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 18 Oct 1991
Launched 20 Nov 1992
Commissioned 9 Jul 1994

WEAPONS SYSTEMS

Mk 26 Mod 1 Launchers

The first five of the class, CG 47-51 are fitted with two twin-arm Mk 26 Mod 1 launchers, positioned immediately before the bridge and aft between the flight deck and the gun. There are two magazines, each holding 22 missiles.

Mk 41 Mod 0 Vertical Launch System (VLS)

CG 52 and all subsequent ships are fitted with two Mk 41 Mod 0 VLS, each holding 61 missiles. A mix of Tomahawk and Standard SM-2MR missiles is normally carried, but there have been occasions when only Tomahawks have been carried.

SURFACE-TO-SURFACE MISSILES

BGM-109 Tomahawk

CG 52 and subsequent ships can carry any version of Tomahawk, which is in service in three versions. Normal load is 8 missiles in each VLS launcher and 12 in the magazines, but on at least one occasion a ship has carried only Tomahawk missiles.

Two versions are for land-attack missions: one has a conventional HE warhead (BGM-109C Tomahawk Land Attack Missile-Conventional (TLAM-C)) and the other carries submunitions (BGM-109D Tomahawk Land Attack Missile-D (TLAM-D)). The third type is the BGM-109B Tomahawk Anti-Ship Missile (TASM), which also has a conventional HE warhead. A fourth version, BGM-109A Tomahawk Land Attack Missile-Nuclear (TLAM-N), has been removed from ships at sea as a result of START I, but is retained in reserve ashore and the ships could quickly be recertified for TLAM-N in an emergency.

The majority now in service are Block II, although the Block III has been in production since 1993 and Block II missiles are being progressively brought up to the new standard. The missile is launched from the VLS powered by a rocket booster until the turbofan engine takes over and the booster is jettisoned.

WEAPON SYSTEMS SUMMARY

	CG 47-51	CG 52-73
Air Defence		
Missile launcher	2 Mk 26 twin-arm launchers	Two Mk 41 vertical launchers
Magazines	2, each 44 missiles	2, each 61 missiles
Missiles	CG 47-48. SM-2MR Block 1 CG 49-51. SM-2MR Block 2	SM-2MR Block 2 or 3 Tomahawk
Anti-ship		
Missile	Harpoon	Harpoon
Number	8	8
Guns		
Main	2–125 mm (5 in)	2–127 mm (5 in)
CIWS	Mod 0 2–20 mm/76 Vulcan Phalanx Mk 15	Mod 1 2–20 mm/76 Vulcan Phalanx Mk 15
Close-range	4–12.7 mm MG	4–12.7 mm MG
Torpedoes		
Tubes	2 triple Mk 32	2 triple Mk 32
Torpedoes	36 Honeywell Mk 46 Mod 5	36 Honeywell Mk 46 Mod 5

Guidance varies between the versions. BGM-109A uses inertial navigation with terrain contour matching (Tercom), while BGM-109B uses inertial plus active radar terminal guidance, and BGM-109C/D inertial and Tercom mid-course guidance with Digital Scene Matching Area Correlation (DSMAC) for terminal guidance. Tercom stores digital terrain profile map information in the missile before launch, which is compared with radar altimeter measurements of ground elevations below the missile during a set number of sections en route to the target. The Block III upgrade programme includes a Global Positioning System (GPS) receiver to supplement or replace the Tercom system. In the terminal phase, DSMAC compares a stored digital representation of the target area with the scene viewed below the missile by a TV camera. This latter system is claimed to be extremely accurate for attacking land targets, with a circular error probable (CEP) of 10 m being reported. Both the BGM-109C and D versions have a programmable terminal dive attack mode option.

The BGM-109A is fitted with a W80 135 kg (298 lb) nuclear warhead, while the BGM-109B/C have 454 kg (1,000 lb) unitary HE warheads taken from old Bullpup B missiles. The BGM-109D has 166 combined effects BLU-97B bomblets, each weighing 1.5 kg (3.3 lb) which can be dispensed in groups against up to four separate targets.

Block III missiles have a more powerful and more fuel-efficient turbofan engine, which, coupled with increased fuel capacity, results in a range increase of at least 30 per cent. The BGM-109C Block III missiles have a smaller WDU-36B 320 kg (700 lb) warhead carrying a unitary HE charge with a selectable fuze delay to increase warhead penetration before detonation.

Specifications

Designation	BGM-109B (Note 1)	BGM-109C Block II	BGM-109D Block II	Block III
Mission	Tomahawk anti-ship missile (TASM)	Tomahawk land-attack missile - conventional (TLAM-C)	Tomahawk land-attack missile - D (TLAM-D)	
Airframe standard	Block II	Block II	Block II	Block III
Length	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)
Diameter	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)
Wing span	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)
Launch weight	1,452 kg (3,201 lb)	1,452 kg (3,201 lb)	1,452 kg (3,201 lb)	n/k
Warheads	454 kg HE (1,000 lb)	454 kg HE (1,000 lb)	166 bomblets	320 kg (705 lb)
Range	240 n miles (450 km)	490-700 n miles (900-1,300 km)	490 n miles (900 km)	690-1,000 n miles (1,285-1,857 km)
Accuracy - circular error probable (cep)	n/a	10 m (33 ft)	10 m (33 ft)	10 m (33 ft)
Speed	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)
In-service date	1983	1983	1989	1993
Engine	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR402 turbofan (335 kg thrust)
Number currently on order	593	1,486	1,157	

Notes
1. BGM-109A (TLAM-N) is not listed as it is not deployed in operational ships, but it should be noted that it remains in reserve ashore

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA (prime).
McDonnell Douglas Missile Systems, St Louis, Missouri, USA (second source)

McDonnell Douglas UGM-84B Harpoon
All 'Ticonderoga' class cruisers carry eight Harpoon anti-ship missiles as part of their weapon load. The canisters are mounted aft in an exposed position on the port side of the fantail. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)

Hue City *(CG 66), the fourteenth of 27 'Ticonderoga' class cruisers to be completed. The Mk 41 Mod 0 vertical launch system immediately before the bridge contains a mix of Standard SM-2MR and Tomahawk missiles and the picture on the right shows* Hue City *launching a Standard missile during trials in 1991* (Ingalls Shipbuilding)

Max speed: Mach 0.85
Range: 67 n mile (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

TORPEDOES

There are six 324 mm Mk 32 (two triple) tubes fitted in the ship's side aft. A total of 36 Mk 46 Mod 5 and Alliant/Westinghouse Mk 50 torpedoes is carried.

	Honeywell Mk 46 Mod 5	Mk 50
Maker	Honeywell	Alliant
Role	ASW	ASW
Homing Range	active/passive 5.91 n miles (9.95 km)	active/passive 8.1 n miles (15 km)
Speed	40 kts	50 kts
Warhead	44 kg (97 lb)	45 kg (99.2 lb)

GUNS

Mk 45 Single 127 mm (5 in) L/54 gun mounting

Two single Mk 45 guns are mounted, one forward, the second aft; Mod 0 in CG 47-50 and Mod 1 in CG 51 onwards. The weapon fires semi-fixed ammunition with point detonating, proximity (variable time or infra-red), mechanical time and electronically set fuzes. The theoretical rate of fire is 20 rds/min and a gun crew of six is required, all below decks, of which four are ammunition handlers. The Mod 1 incorporates a number of improvements, including the ability to change the type of ammunition under remote control and electronic fuze setting.

Improvements under consideration include the Mk 45 Mod 3 (Near Term solution) which would upgrade the Mk 45 to attain ranges of 20 n miles (37 km) through improvements to the ballistic characteristics of the round and the charges. This may be fitted to the Ticonderogas, but the Mid-Term solution, which is intended to provide ranges in excess of 30 n miles (55.5 km) could not be fitted due to topweight restrictions.

Specifications

Calibre: 127 mm (5 in)
Length of barrel: 54 calibres
Muzzle velocity:
new barrel: 807.72 m/s (2,650 ft/s)
mid-life: 762 m/s (2,500 ft/s)
Crew: 6 (1 mount captain, 1 panel operator, 4 ammunition handlers)
Traverse: 340° at 30°/s
Elevation: −15 to +65° at 20°/s
Range:
anti-ship: 12.39 n miles (23 km)
anti-air: 15,000 m (49,000 ft)
Rate of fire: 16-20 rds/min
Ammunition weight: 31.75 kg (70 lb) (projectile)

Manufacturer/Contractor

United Defense, Armament Systems Division, Minneapolis, Minnesota, USA.

Hughes Mk 15 CIWS Phalanx

Two Hughes Mk 15 Phalanx close in weapons systems (CIWS) provide the innermost layer of defence against anti-ship missiles. The two mounts are situated high on the superstructure immediately abaft the foremast. Each mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n miles (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds. The mount can be fitted with high-definition thermal imagers (HDTI) for tracking small craft.

Specifications

Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n mile (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

Manufacturer/Contractor

Hughes Missiles, Tucson, Arizona, USA.

Machine-guns

Four 12.7 mm MGs.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

AN/SLQ-32(V)3 Sidekick ESM Suite

The SLQ-32(V)3 suite is designed to give radar warning and jamming/deception for larger ships of the US Navy. The ESM capability is the same as that of the (V)2 suite, but extra equipment racks are added in the EW room and computer memory has been increased from 64 to 80 K. The hydraulically roll-stabilised, outboard antenna assemblies are also enlarged to accommodate Band 3 transmitter antennas and electronics; two are located in the lower portion of each assembly. The AN/SLQ-32(V)3 AECM mode can be operated semi-automatically, where the operator initiates jamming against a given emitter, or automatically under computer control, where the system initiates countermeasure action as soon as a threat is identified, generating an appropriate response in the required direction, with the computer scheduling transmissions, so that multiple targets can be countered simultaneously.

Manufacturer/Contractor

Raytheon Company, Electromagnetic Systems Division, Goleta, California.

ELECTRONIC COUNTERMEASURES (ECM)

AN/SLQ-25 Nixie noisemaker

One AN/SLQ-25 Nixie (Phase 1), solid-state, modular design electroacoustic countermeasures decoy system used to protect the carrier from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller,

Normandy *(CG 60)* (Jane's/HM Steele)

the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 487.5 m (1,600 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408.24 kg (900.2 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 94.6 cm (3.1 ft) long, 15.24 cm (6 in) in diameter and weigh 18.14 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body at a time is deployed.

Manufacturer/Contractor
Aerojet ElectroSystems, Sacramento, California, USA.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher
Four or six Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications
Launcher
Dimensions: 160 × 43 × 86 cm
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Rounds
Mk 182: 1,209 × 130 mm; 22.7 kg
Super Chaffstar: 1,209 × 130 mm; 20.9 kg
Super Gemini: 451 × 130 mm; 5.5 kg
Super Hiram III: 1,220 × 130 mm; 13.6 kg
Super Hiram IV: 467 × 130 mm; 3.8 kg
Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturers/Contractors
Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Communications Links
NTDS
Link 4A
Link 11
Link 14
JMCIS (being fitted)
Link 16 (being fitted)

Computers
UYK-7 and UYK-20 computers (CG 47-58)
UYK-43 and UYK-44 (CG 59 onwards)
SQQ 28 is the shipboard processor for data from sonobuoys in LAMPS-III system

Communications systems
Satcom
SRR-1
WSC-3 (UHF)
USC-38 (EHF)
Tacan: URN 25
IFF: Mk XII AIMS UPX-29

WEAPONS CONTROL

Aegis Mk 7 Weapon System/GWS Mk 34/ FCS Mk 99
The Aegis system is the most sophisticated and comprehensive naval command and weapon control system in service in any navy and takes its name from Greek mythology, where the 'aegis' was the shield used by Zeus, chief of the gods. The US Navy's Aegis command and weapon control system integrates the management of a task group's combat assets for air, surface and underwater operations, although the emphasis is upon air operations. It is designed to react quickly and with sufficient firepower to destroy fast, intelligent targets in severe ECCM and environmental conditions. The system is based on a federated architecture consisting of four subsystems: multifunction radar; Command and Decision System (CDS); Aegis Display System (ADS); and the Weapons Control System (WCS). The system uses the CSM-2 software language, although there are plans to use Ada. There are currently five basic configurations (known as 'baselines') and seven versions (designated 'modifications' (Mods)), and both hardware and software are continually upgraded.

The prime sensor in Baseline 0, 1 and 2 systems is the AN/SPY-1A, an E/F-band (2-4 GHz) multifunction radar. This conducts horizon and hemispherical searches, multiple target tracking and multiple target designation, as well as providing a two-way link with missiles for mid-course guidance when instructed to do so through the weapon control system. Baseline 3 ships have SPY-1B while Baseline 4 ships have SPY-1B (V). Each SPY-1 has the four characteristic antennas installed in the superstructure, which are angled upwards at approximately 45° to enable them to maintain accurate co-ordination even when the ship is rolling at angles of ±30° or pitching at ±15°. The two front antennas face forward and to starboard while the rear antennas face the stern and to port.

In the SPY-1A each antenna has its own transmitter and receivers and a signal processor controls the high-power, ultra-precision, garnet, phase shifters which integrate microwave and electronic hardware. There are 4,100 phase shifters in each antenna steering the beam to cover the sectors and designated targets, although some phase shifters are also used to eliminate sidelobes. The antennas in the SPY-1B are of a new and much lighter design, with much lower sidelobes, an improved signal processor and a new transmitter tube which has double the duty cycle with the same peak power. Both this system and the similar SPY-1D make greater use of VLSI technology.

Port Royal *(CG 73) was the last of the 'Ticonderoga' class cruisers to be commissioned on 30 March 1994. The huge deckhouses carry the four planar arrays for the SPY-1A radar. The antennas on the bridge roof are the tripod-mounted SPQ-9A, two SPG-62 illuminators and (pointing to the horizon) the OE-82 antenna for the WSC-3 SATCOM system. Note also just ahead of the ship's launch the antenna array for the SLQ-32* (Ingalls Shipbuilding)

RADARS

	SPY-1	SPS-49(V)7	SPS-55	SPS-67(V)2	SPS-64(V)9
Manufacturer	Lockheed Martin	Raytheon	Cardion	Norden	Raytheon
Role	3-D air search	Air search	Surface search	Surface search	Navigation
Band	E/F (2-4 GHz)	C/D (0.5-2 GHz)	I/J (8-20 GHz)	H (5.45-5.83 GHz)	I/J (9.3-9.4 GHz)
Beam	1.7 × 1.7°	3.4 × 30° csc²	1.5 × 20°	1.5 × 16°	1.9 × 22°
Peak power	4-6 MW	360 kW	130 kW	500 kW	20 kW
Gain	42 dB	28.5 dB	31 dB	30 dB	28 dB
Pulsewidth	51/25.4/12.7/6.4 µs	125/2 µs	1/12 µs	0.1/0.25/1 µs	0.06/0.5/1.0 µs
PRF	Variable	280/800/1,000 pps	750/2,250 pps	2,400/1,200/750 pps	3,600/1,800/900 pps
Scan rate	12 scans/min	6/12 rpm	16 rpm	15 rpm	33 rpm

The SPY-1 radar is supplemented by a number of dedicated radars (see table), including the SPS-49, very long-range, air search radar whose high average power can help detect low cross-section threats with great precision (0.03 n miles (0.05 km) in range and 0.5 m (19.7 in) in height) even in severe EW environments and possesses an automatic target detection capability. The SPS-55 surface search and navigation radar is used to detect small surface targets, for tracking low-flying aircraft and for detecting submarine periscopes. The antenna consists of two back to back, end-fed, slotted arrays of which one has circular polarisation and the other linear-horizontal polarisation. The SPS-67 surface search radar has been developed from the SPS-10 and retains the earlier set's open lattice construction, horn feed antenna. Performance is further improved by a digital video clutter suppressor and an interference suppressor.

The Command and Decision System (CDS) Mk 1 provides overall operational direction and co-ordination, receiving data not only from onboard sensors, but also from offboard sensors via Link 11 and Link 14. In addition to inputs from radar and sonar sensors CDS also receives inputs from the AN/SLQ-32 electronic warfare suite. The system is used to help assess threats and will assign engagement instructions to the WCS.

CDS Mk 2, installed in Baseline 4 ships receives further direct inputs from the SQQ-89 sensors both onboard through the Mk 116 fire-control system and offboard from the Light Airborne MultiPurpose System (LAMPS) ASW helicopter datalink, as well as from more distant sensors via Link 16 (JTIDS).

The Aegis Display System (ADS) enables the ship's commander, his tactical action officer and the task group commander (if embarked) to assess the operational situation and to issue orders both to onboard and offboard weapon systems and units.

The Weapons Control System (WCS) conducts the engagement of targets in the air, on the surface and underwater, although priority is given to the anti-air battle. The system interfaces with sensors of various onboard systems and offboard systems with direct links to the LAMPS ASW helicopter and through Link 4A to aircraft. The system receives engagement instructions through the CDS and selects the appropriate weapons system and weapon. It schedules targets, issues firing orders and controls surface-to-air missiles launched by the Mk 99 fire-control system until they are close to the interception point.

The WCS interfaces with several fire-control systems and the Phalanx CIWS. The fire-control systems are the Mk 86 Mod 9 fire-control system which uses an AN/SPQ-9 fire-control radar to support the 127 mm (5 in) guns, the Mk 116 anti-submarine system, the AN/SWG-1A (Harpoon) and AN/SWG-3A (Tomahawk), the Mk 116 underwater fire-control system, the LAMPS Mk I/III ASW helicopter, the missile launching system (Mk 26 or Mk 41) and the Aegis integral surface-to-air missile fire-control system, the Mk 99. In the Baseline 1 cruisers the AN/SQS-53A sonar is linked into the WCS through a UYK-20A computer.

In the engagement of air targets the WCS is supported by the Mk 99 fire-control system (Mods 1 and 2). This has a UYK-7 computer. The Mk 99 generates director and launcher commands for the slaved illuminators which are also used to provide target illumination for missiles from other ships, selects the missile engagement mode then acquires and tracks the target using uplink mid-course command guidance through the SPY-1, which generates continuous targeting data, to guide the missile close to the target which is then illuminated by the SPG-62s for the terminal phase.

The Aegis system has four operating modes; automatic, automatic special, semi-automatic and casualty. The automatic special mode ensures that targets which meet predetermined threat criteria will be automatically engaged unless the order is overridden manually. The other modes are self-explanatory but in all of them the firing is initiated manually. The command system monitors the whole Aegis system through the ORTS which monitors critical operating points, detects faults and provides maintenance data for the crew. The Mk 1 system is used in earlier ships and Mk 7 in later ones.

The WCS accepts weapon assignment commands and special threat criteria from the command system, together with tracking data from the multifunction radar. The data are processed and also displayed on the display system to determine the possibility of engaging the target. Traverse and elevation commands are then transmitted to the launcher and pre-launch commands are transmitted to the missile, together with target illumination data for the Mk 99 fire-control system. Trail intercepts are computed and time-to-fire predicted, the data being transmitted to the command system. Once the missile is fired the weapons control system can request the command system to carry out mid-course guidance through the multifunction radar. In the cruiser system the illuminators can support between 12 and 18 missiles simultaneously on a time-share switching basis.

Six Aegis 'baselines' were planned, which are summarised in the table below. In the event, Baseline 5 was not installed and the final four ships were completed to Baseline 4, with elements of baseline 5 being backfitted during overhauls.

AEGIS BASELINES

Baseline (Ships)	Missiles	Radar	CDS	Computer system	Display system	GMLS/GMVLS	Helicopter	Additional features
0 **CG 47-48**	SM-2 MR Block 1	SPY-1A	Mk 1	UYK-7 UYK-40	UYA-4 ADS-1	Mk 26	LAMPS I	LAMPS I SQS-53A/B
1 **CG 49-51**	SM-2 MR Block 2	SPY-1A	Mk 1	UYK-7 UYK-20	UYA-4 ADS-1	Mk 26	LAMPS III	LAMPS III SQS-53A/B
2 **CG 52-58**	SM-2 MR Block 2	SPY-1A	Mk 1	UYK-7 UYK-20	UYA-4 ADS-1	Mk 41	LAMPS III	Tomahawk missile SQQ-89 upgrade
3 **CG 59-64**	SM-2 MR Block 2/3	SPY-1B	Mk 1	UYK-7 UYK-20	UYQ-21 ADS-1	Mk 41	LAMPS III	Improved communications
4 **CG 64-69**	SM-2 MR Block 2/3	SPY-1D	Mk 2	UYK-43 UYK-44	UYQ-21 ADS-2	Mk 41	LAMPS III	SQS-53C SQR-19
5 **CG 70-73**	SM-2 MR Block 4	SPY-1D	Mk 2	UYK-43 UYK-44	UYQ-21 ADS-2	Mk 41	LAMPS III	Link 16 (JTIDS), SQQ-89(V)6 SLQ-32(V)3 Combat DF Tadix B

A Baseline 6 was planned with the EDM-4B radar, an enlarged Mk 41 VLS, co-operative engagement SM-2, Embarked LAMPS Mk III, AN/SQQ-89 (I) (I = Improved) and the SSTD-02 torpedo decoy. With the cancellation of AN/SQQ-89 (I), however, Baseline 6 may be reduced to elements which will be retrofitted into Aegis ships.

In addition to the baselines there are a number of modifications to the Aegis system which are summarised here:

AEGIS MODIFICATIONS

Modification	Ships	Outline
0	CG 47-48	Baseline 1 with LAMPS I, LN-66 navigation radar
1	CG 49-51	Baseline 1 with LAMPS III, SPS-64 navigation radar
2	CG 52-57	Baseline 2 without SQQ-89. CG 54 onwards have AN/SQR-19 TACTAS (TACtical Towed Array Sonar) and AN/SQQ-28 helicopter datalink CG54 and 55 with SQQ-89(V)2
3	CG 56-58	Baseline 2 with AN/SQQ-89(V)3
4	CG 59-64	Baseline 3 with SSQ-89(V)3
5	CG 65-69	Baseline 4 with Mk 12 WDS, SSQ-89(V)7, SLQ-32(V)3

Manufacturers/Contractors

Lockheed Martin, Government Electronic Systems (prime).
Unisys (computers).
Computer Sciences Corporation (software).
Hughes Aircraft Company (displays).
Raytheon (Mk 99 fire-control systems)

Mk 116 Mod 7 anti-submarine fire-control system

The Mk 116 Underwater Fire-Control System is designed to provide tactical data processing, contact management, target engagement processing and weapon fire control. There is a variety of versions, those in the 'Ticonderoga' class being:

Ships	ASW Fire-Control System	ASW Combat System
CG 47-53	Mod 4	
CG 54-55	Mod 4	SQQ-89(V)2
CG 56-64	Mod 6	SQQ-89(V)3
CG 65	Mod 7	SQQ-89(V)3
CG 66-67	Mod 7	SQQ-89(V)7
CG 68-73	Mod 7	SQQ-89(V)6

The Mk 116 consists of two elements: the Computer Processing Subsystem (CPS) and the Weapon Control and Setting Subsystem (WCSS). Data are also received from external sensors and distributed around the system by an integral switchboard or data converter.

The CPS provides displays of tactical data, computes and stores track data, calculates weapon control firing solutions for selected targets and generates weapon recommendations and launcher orders. Most systems are based upon NTDS hardware with an AN/UYK-43 computer with a memory of 256,000 32-bit words and an optimum processing power of 667,000 operations/s. The newest systems have two AN/UYK-43B computers, each of which has two Central Processing Units (CPU) with a memory of 2,560,000 words and an optimum processing power of 3,002,000 operations/s. Both systems use the US Navy's own CMS-2 language.

The WCSS is basically the same in all the Mk 116 systems, except for the Mod 7, which is the version used in CG 56-73. It consists of the Mk 329 weapon control panel which selects the fire-control mode, the sensor-weapon pairing, weapon and launcher, torpedo presetting and then launches the weapon. The external sensors all include an electromagnetic log and the Type F wind indicator. The other sensors and the data distribution unit are tabulated alongside.

The prime sensor is the bow-mounted, low-frequency AN/SQS-53 active/passive sonar which is produced by the General Electric Company's Electronic Systems Division (SQS-53A)

Manufacturer/Contractor

Loral Librascope, Glendale, California, USA.

Mk 86 Mod 9 gun fire-control system

There is one Mk 86 Mod 9 GFCS for gun fire control. The Mk 86 system assists direct and indirect naval gun fire support and also supports the engagement of both surface and air targets. Using a mainframe architecture and CMS-2 software language, it consists of a computer system, a display system and as many as three sensors, and accepts data from NTDS, the Mk 74 fire-control system and optical Target Designation Transmitters. The system uses the AN/UYK-7 32-bit computer with a memory of 256,000 words and an operating speed of 667,000 operations/s and can track 120 targets.

The primary sensor is the AN/SPQ-9A fire-control radar, together with a remotely operated electro-optic tracker known as the Remote Optical Sight (ROS) of which there are usually two. AN/SPQ-9 is a high-resolution, track-while-scan, pulse compression I-band radar which provides detection and tracking facilities against surface targets at ranges between 135 m (443 ft) and 20 n miles (37 km) and limited air cover at altitudes up to 610 m (2,000 ft). The search-to-acquire capability is computer directed and the radar can accept 2D and 3D target designation co-ordinates in digital or synchro format.

In general, the Mod 9 has the same capabilities as the Mod 3, but there is no AN/SPG-60 radar, the Mk 152 computer is replaced by an AN/UYK-7, and WCCs replace the GCC.

Manufacturer/Contractor

Lockheed Electronics Company Inc, Nashua, New Hampshire, USA.

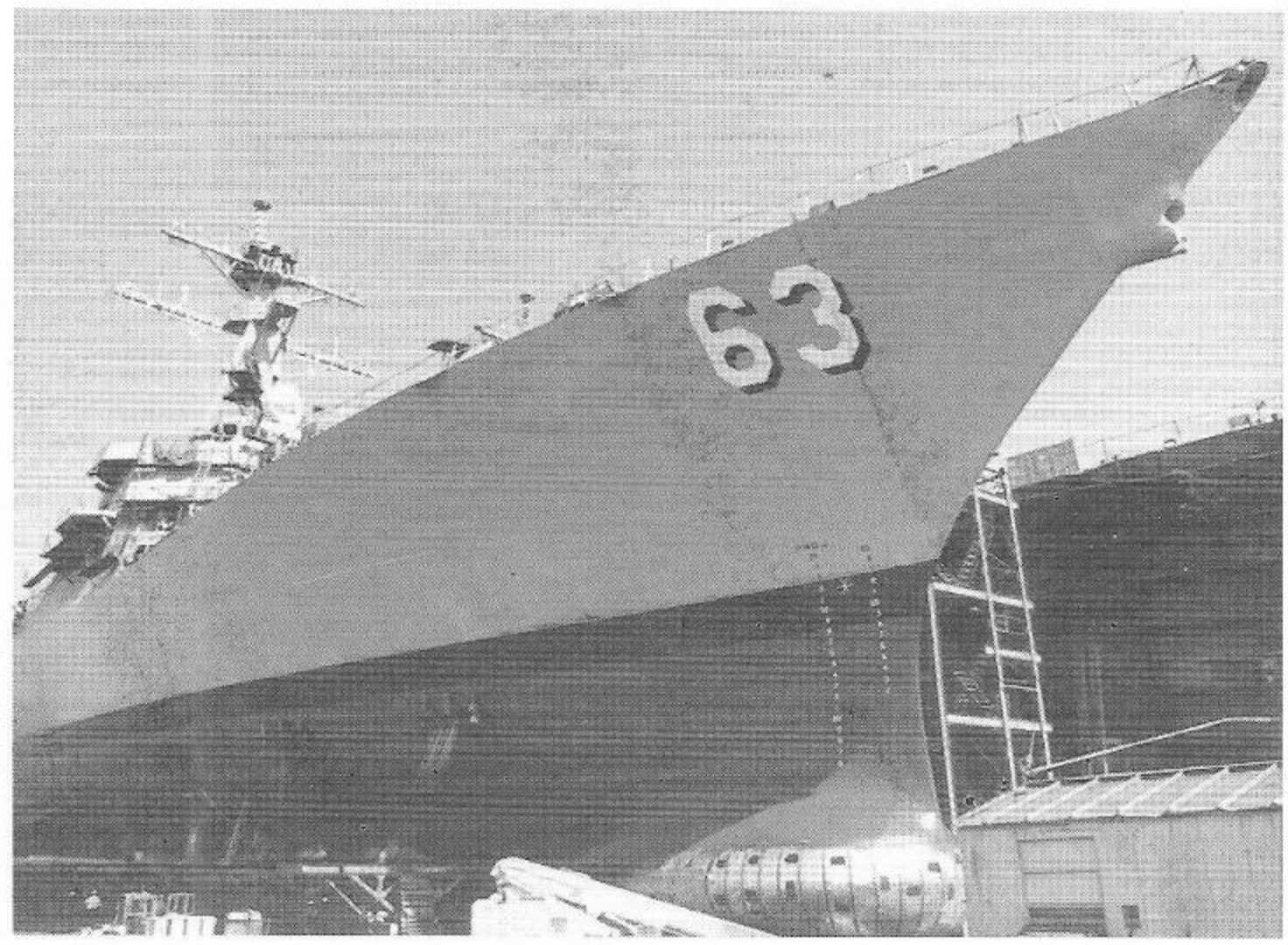
SONARS

SUMMARY

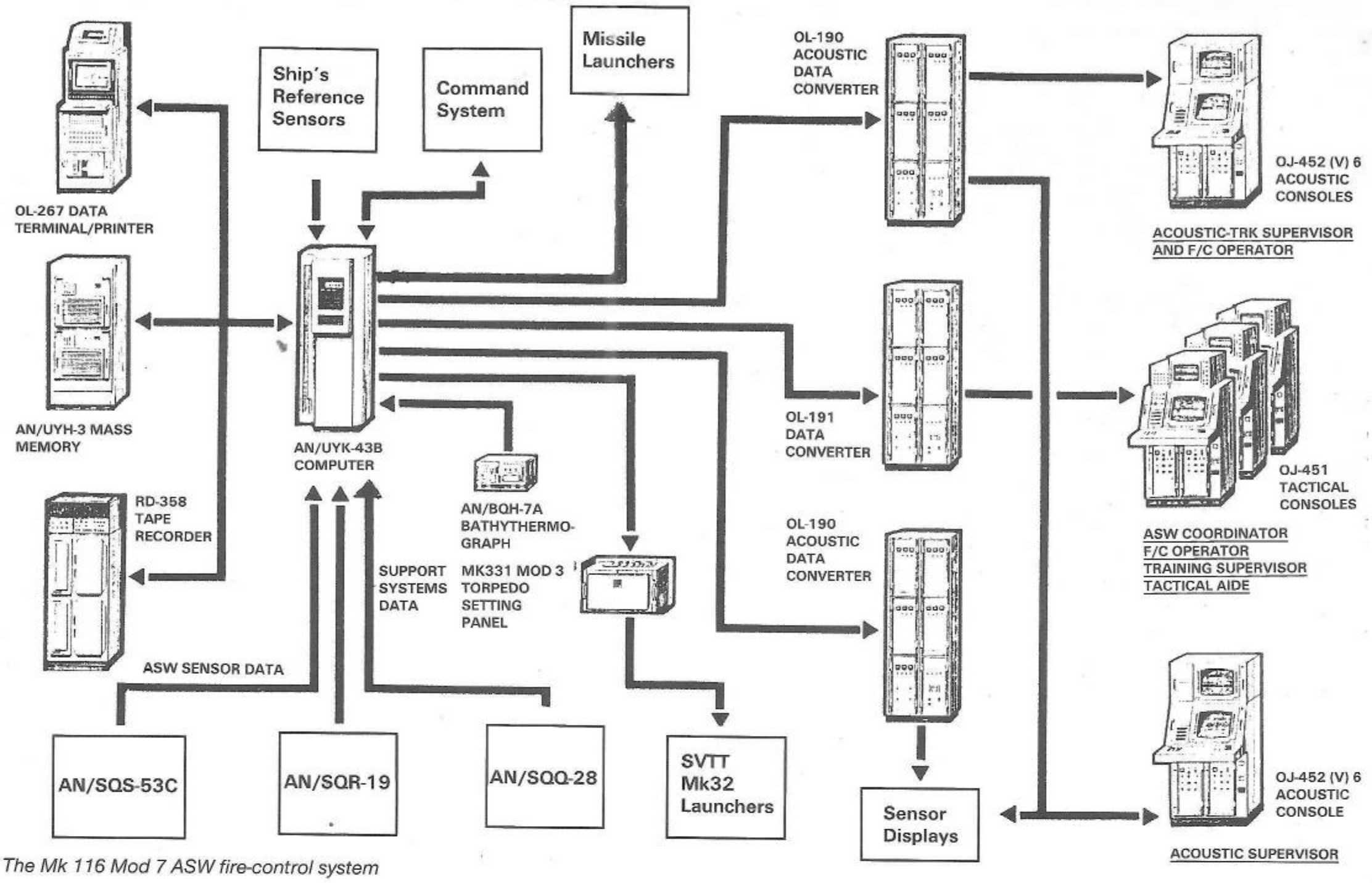
Type	Designation	CG 47-53	CG 54-55	CG 56-65	CG 66-67	CG 68-73
Integrated sonar suite	SQQ-89(V)3		✓	✓	✓	✓
Bow-mounted active, search/attack sonar	SQS-53A	✓	✓			
	SQS-53B			✓	✓	
	SQS-53C					✓
Passive towed array (TACTAS)	SQR-19(V)2		✓			
	SQR-19(V)3			✓		
	SQR-19(V)6					✓
	SQR-19(V)7				✓	

AN/SQQ-89 anti-submarine combat system

AN/SQQ-89(V) anti-submarine warfare combat system is an integrated sonar suite which is designed to detect, locate, track and engage submarine targets. It transmits and/or receives acoustic signals using a variety of sensors to provide target classification as well as performing TMA and controlling the setting of 'own ship' ASW weapons. In addition it provides multisensor track correlation, track management control and forwards track data to the ship's Combat Direction System (CDS) or Command and Decision System (C&DS). Although



This shot of Cowpens *(CG 63) prior to completion shows the bow dome for the AN/SQS-53B sonar. It also illustrates why ships with such a sonar need such an overhanging bow to carry the anchor clear of the dome* (Ingalls Shipbuilding)



The Mk 116 Mod 7 ASW fire-control system

the AN/UYK-43B processor is used, more than 85 per cent of the software continues to be in CMS-2 (CMS-2Y). The system is an integrated combat system which consists of two or three sonar sensors which interface either with the Mk 116 fire-control system or a Weapons Alternate Processor (WAP). This integration provides maximum operational effectiveness while requiring the minimum manpower to operate the equipment. Sensors integrated in AN/SQQ-89(V) are the GE Electronic Systems Division AN/SQS-53B/C hull-mounted sonar, the GE Electronic Systems Division AN/SQR-19(V) Tactical Towed Array Sonar (TACTAS), the AN/SQQ-28 LAMPS I/III Sonar Signal Processing System (SSPS) all supported by the AN/UYQ-25 Data Processing System (DPS) and its associated Sonar In-Situ Mode Assessment System (SIMAS) computer program. The fire-control subsystem is usually the Mk 116 Mods 5-9.

Manufacturer/Contractor

Lockheed Martin Ocean and Radar Systems, Baltimore, Maryland, USA.

AN/SQS-53

The basic element of the Ticonderogas' sonar suite is the AN/SQS-53 bow-mounted, low-frequency, active/passive sonar. The array is cylindrical, 1.6 m (5.2 ft) high and 4.8 m (15.7 ft) in diameter, with 576 transducers, with a power requirement of some 65 kW. Active transmitting frequency is estimated to be about 3 kHz with a peak frequency of 192 kHz. There are three active modes: surface duct, bottom bounce and convergence zone. Estimated range is in the region of 10 n miles (18.5 km) in surface duct mode and up to 34.5 n miles (64 km) in convergence zone mode. Compared to its predecessor, SQS-26, SQS-53 has greater passive detection range, the ship is able to operate at higher speeds and the new system also gives the ship a multiple target tracking capability.

There are three versions: SQS-53A, B and C. SQS-53A and SQS-53B have 37 cabinets of signal processing, transmitting and display equipment, the latter having digital display subsystems. Both systems were scheduled to be upgraded to SQS-53C standard, reducing the number of cabinets to 15.

SQS-53B is essentially a modernised SQS-53A with the AN/UYK-20 computer replaced by the AN/UYK-44 Military Reconfigurable Processor (MRP), some modified and some new sonar cabinets, some new computer programs and improved control and display subsystem.

SQS-53C is an upgraded SQS-53B which can detect, classify and locate both subsurface and surface targets using active and passive means. It consists of four major subsystems, the array, the transmitter, the receiver and the control/display.

Manufacturers/Contractors

General Electric Company, Electronic Systems Division (SQS-53A).
Hughes Aircraft Company Systems Group (SQS-53B).
Westinghouse Electric Corporation (SQS-53C).

AN/SQR-19(V)

The AN/SQR-19(V) is a passive, long-range omnidirectional system for detecting and classifying submarine targets. Its OA-9056/SQR-19 towed array group consists of an 82 mm (3.2 in) diameter array which is towed on a 1 n mile (1.7 km) cable to depths as great as 365 m. The two other major subsystems are the Ship-based Electronic Subsystem (SES) and the OK-410/SQR-19 Handling and Stowage Group (H&SG). Early versions of AN/SQR-19 use the AN/UYK-20 Data Processing Set (DPS) but systems produced from FY87 onwards use the AN/UYK-44-based Signal Data Processing Unit (SDPU).

AN/SQQ-28

The AN/SQQ-28 SSPS (shipboard sonar processing system) was originally designed as the shipboard processor for the LAMPS Mk III weapon system. It processes raw data from sonobuoys laid by the Sikorsky SH-60B Seahawk ASW helicopter and relayed to the ship via the AN/SQR-4 duplex digital link and received by the AN/ARR-75. LAMPS I acoustic data, from sonobuoys laid by the Kaman SH-2F Seasprite, is received by the Naval Sea Systems Command-developed AN/SKR-4B(V) receiver. Modifications to the SKR-4 interface allow LAMPS I and LAMPS III interoperability, and shipboard sonobuoy receiver set or training acoustic inputs to the datalink port of the SQQ-28 Input Signal Switching Unit (ISSU). LAMPS I/III interoperability kits are installed in 'Ticonderoga' class cruisers from *San Jacinto* (CG 56) onwards and are being retrofitted selectively.

Anzio *(CG 68). Visible in this picture are the AN/SPS-64(V)9 navigational radar in the small radome on the small platform near the top of the mainmast, the flight deck, the after Mk 41 vertical launch groups and the gun in 'Y' position. The mounting brackets for the eight Harpoon launchers are on the quarterdeck but the launcher canisters are not fitted*

AVIATION

HELICOPTERS

The Ticonderogas carry two helicopters: two Kaman SH-2F LAMPS I in the case of CGs 47-48; and two SH-60B Sea Hawk LAMPS III in the remainder. The flight deck is placed well forward of the usual stern position and thus the effects of pitch and heave will be noticeably less. The large after superstructure accommodates the hangar, with the after engine uptakes to starboard and the astern- and port-looking SPY-1A phased arrays on the port side of the hangar roof.

Kaman SH-2G/LAMPS I Super Seasprite

Specifications

Main rotor:
- **diameter:** 13.51 m (44.33 ft)
- **disc area:** 143.41 m² (1,543.66 sq ft)

Tail rotor:
- **diameter:** 2.46 m (8.15 ft)
- **disc area:** 4.77 m² (51.32 sq ft)

Length overall (both rotors turning): 16.08 m (52.75 ft)
Fuselage length: 12.19 m (40.00 ft)
Height to rotor head: 4.58 m (15.00 ft)
Weights:
- **empty:** 3,447 kg (7,600 lb)
- **max take-off:** 6,124 kg (13,500 lb)

Max level speed at sea level: 138 kts (256 km/h)
Typical cruising speed: 120 kts (222 km/h)
Service ceiling: 7,285 m (23,900 ft)
Range with max standard fuel: 478 n miles (885 km)
Power plant: 2—1,285 kW (1,723 shp) General Electric T700-GE-401 turboshafts
Accommodation: Crew of 3 in ASW role (pilot, co-pilot/tactical co-ordinator, sensor operator
Sensors: Canadian Marconi LN-66HP surveillance radar; AN/ALR-66(V)1 radar warning/ESM; Teledyne Systems AN/ASN-150 tactical management system; dual Collins AN/ARC-159(V) UHF radios; Texas Instruments AN/ASQ-81(V)2 MAD; Computing Devices AN/USY-503 acoustic processor; Flightline Electronics AN/ARR-84 sonobuoy receiver and AN/ARN-146 on-top position indicator. Tele-Dynamics AN/AKT-22(V)6 sonobuoy datalink; 15 DIFAR and DICASS sonobuoys. AN/ALE-39 chaff/flare dispensers; AN/ASQ-18B torpedo presetter
Weapons: 1/2 Mk 46 or Mk 50 torpedoes; eight Mk 25 marine smoke markers. Provision for pintle-mounted 7.62 mm MG in both doorways

Sikorsky SH-60B Seahawk (LAMPS III)

Specifications

Dimensions
Main rotor:
- **diameter:** 16.36 m (53.66 ft)
- **disc area:** 210.15 m² (2,262 sq ft)

Tail rotor:
- **diameter:** 3.35 m (11.00 ft)
- **disc area:** 8.83 m² (95.03 sq ft)

Length overall:
- **fuselage:** 15.26 m (50.0 ft)
- **rotors turning:** 19.76 m (64.83 ft)
- **rotors/tail pylon folded:** 12.47 m (40.91 ft)

Height:
- **to top of rotor head:** 3.79 m (12.43 ft)
- **overall, tail rotor turning:** 5.18 m (17.0 ft)
- **overall, pylon folded:** 4.04 m (13.25 ft)

Weights:
- **empty:** 6,191 kg (13,648 lb)
- **mission gross weight:** 9,182 kg (20,244 lb)

Performance:
- **dash speed (typical):** 126 kts (234 km/h)
- **vertical rate of climb at S/L:** 213 m (700 ft)/min

Power plant:
- **pre-1988:** 2 General Electric T700-GE-401 turboshafts rated at 1,260 kW (1,690 shp) 1,342 kW (1,800 shp)
- **1988 and after:** 2 General Electric T700-GE-401C turboshafts rated at 1,417 kW (1,900 shp)

Accommodation: 4 (Pilot and airborne tactical officer/back-up pilot in cockpit, sensor operator in specially equipped station in cabin)
Communications: Collins AN/ARC-159(V)2 UHF, Collins AN/ARC-174(V)2 HF, Hazeltine AN/APX-76A(V) and Bendix/King AN/APX-100(V)1 IFF transponders, TSEC/KG-45(E-1) communications security set, TSEC/KY-75 voice security set, Telephonics OK-374/ASC communications system control group
Mission avionics: Sikorsky sonobuoy launcher, Edmac AN/ARR-75 and R-1651/ARA sonobuoy receiving sets (AN/ARR-84 receiver in Block 1 upgrade), Texas Instruments AN/ASQ-81(V)2 towed-MAD, Raymond MU-670/ASQ magnetic tape memory unit, Astronautics IO-2177/ASQ altitude indicator, Fairchild AN/ASQ-164 control indicator set, Fairchild AN/ASQ-165 armament control indicator set, IBM AN/UYS-1(V)2 Proteus acoustic processor and CV-3252/A converter display, Control Data AN/AYK-14 (XN-1A) digital computer, Raytheon AN/ALQ-142 ESM, Sierra Research AN/ARQ-44 datalink and telemetry
Armament: 2 Mk 46 torpedoes AGM-119B Penguin Mk 2 Mod 7 anti-shipping missiles. Block I upgrade integrated Penguin and Honeywell Mk 50 Advanced Lightweight Torpedo

PROPULSION

Specifications
System: Gas turbine
Main machinery: 4 General Electric LM-2500 gas turbines; 64.16 MW (86,000 hp) sustained
Electric power supply: 3 gas turbines; 2,500 kW each
Shafts: 2
Propeller: 2 controllable pitch propellers

FURTHER INFORMATION

PROGRAMME

The single most important feature of these ships is the Aegis system, which offers a number of major advantages, including the extended range of its sensors, its fast reaction time, the capacity to track many targets simultaneously, its ability to transmit this information to other units automatically, and its data displays which combine sensor information with other inputs. Further, due to its very long-range radar cover, it gives operators additional time to react, to gather data, and to make considered judgements, although during littoral operations these advantages can be eroded. An upgraded Standard missile is under development, which, in combination with the Aegis system, will give the first naval defence against ballistic missiles.

A number of ship designs to accommodate the Aegis system was considered during the late 1960s and throughout the 1970s. These included conversions of various existing designs, such as the 'Long Beach' (CGN 9) and the 'Virginia' (CGN 38) class, and new construction ships, including a conventionally powered destroyer and a nuclear-powered strike cruiser. Eventually, however, it was decided to build a modified version of the Spruance design, with the first of class being laid down in January 1980.

Construction then proceeded at a steady pace until delays encountered in the construction of the 'Arleigh Burke' class destroyers, and the realisation that the navy was in no position at that time to award further contracts for construction of more DDG 51s led to the last five being approved in the FY88 ship construction budget.

DESIGN

The 'Ticonderoga' class design is a modification of the 'Spruance' class. It uses the same basic hull, although it has been extended slightly in length (from 171.7 m (563.2 ft) to 172.8 m (567 ft)), has a somewhat greater draught and is fitted with a bulwark, which stretches from the bow as far back as the forward 127 mm (5 in) gun turret. The superstructure is much larger to accommodate the antenna arrays and other elements of the SPY-1A system, but despite the increase in topweight, there is no requirement for stabilisers to be fitted.

The propulsion system, consisting of four General Electric LM-2500 gas turbines, is the same as in the Spruances, but there is an increase in output from the three auxiliary generators from 2,000 kW to 2,500 kW to meet the additional power requirements. The machinery exhausts are also noticeably higher than in the 'Spruance' class.

Command and control spaces, magazines and electronic installations are protected by Kevlar armour.

The first two ships have a square, four-legged mainmast, but *Vincennes* (CG 49) and all later ships have a lighter tripod.

MODERNISATION

Because the building programme involved a large number of ships being built over an extended period, the Long-Range Improvement Programme was devised in order to phase in the latest technological developments. Such a method of incremental upgrading of ship capabilities provides the best available combat system to the fleet while reducing operation and support costs. This has resulted in five build standards, known as Baselines 0 to 4, respectively.

Baseline 0: CG 47,48 The original standard, which includes the base model SPY-1A Aegis Mk 7 system, and the Kaman SH-2F LAMPS I ASW helicopter.
Baseline 1: CG 49-51 The LAMPS I system was replaced by the Sikorsky SH-60B LAMPS III system, which required the RAST haul-down flight deck helicopter retrieval and manoeuvring system. In addition, Standard SM-2MR Block 2 missiles replaced Block 1, and a three-legged mainmast replaced the earlier four-legged version.
Baseline 2: CG 52-58 The most significant change was that the twin-armed Mk 46 missile launchers were replaced by the Mk 40 Mod 0 vertical missile launching system. This launches Standard missiles.
Baseline 3: CG 56 onwards This added the SQQ 89 sonar suite, consisting of SQQ-53B hull-mounted sonar, SQR-19 towed array, and the Mk 116 Mod 6 fire-control system.
Baseline 4: CG 59 onwards The original SPY-1A was replaced by the more advanced AN/SPY-1B radar with UYQ-21 displays and includes the upgraded computers UYK-43/44 and improved displays.

DESIGNATION

These ships were originally classified as guided missile destroyers (DDG), but this was changed on 1 January 1980 to guided missile cruiser (CG). Despite this, the 'Spruance' class, on which the 'Ticonderoga' class is closely based, remained classified as destroyers.

OPERATIONAL

The first of class was commissioned in 1983 and since then many Ticonderogas have seen operational service. *Yorktown* (CG 48) provided the air-intercept support for navy fighters intercepting the Egyptian airliner carrying the hijackers of the cruise ship *Achille Lauro* from Egypt to Tunisia.

Vincennes *(CG 49) was the third of class to be completed and in 1988 was involved in an incident, while operating in the Gulf, in which an Iranian civil airliner was shot down with heavy loss of life. Both procedural and technological steps have been taken to ensure that such an event never recurs* (RAN)

In March-April 1986, *Yorktown* (CG 48) and *Vincennes* (CG 49) were focal points of the successful operations in the Gulf of Sidra, which included the sinking of two Libyan patrol boats and strikes by carrier-based US Navy aircraft and shore-based F-111s against Libyan missile sites and other targets.

In 1988 *Vincennes* was involved in an incident which remains controversial to this day, when it misidentified and shot down an Iranian airliner which appeared to be approaching the ship at the same time that it was involved in a surface engagement with Iranian gunboats. In view of the heavy loss of life involved, the incident was exhaustively investigated, the enquiry reporting that the Aegis system had performed as designed and that the sensor data collected was accurate, but adding that 'it should be appreciated that Aegis is not capable of identifying the type of aircraft being tracked'. Ships of the class were again active in directing the air defence of the northern Gulf during the Iraq war in early 1991. *Princeton* was damaged by a mine; repairs were completed in December 1991. Seven of the class fired Tomahawk missiles and others of the class fired again in January and June 1993 at targets in Iraq.

It was reported that radar coverage in the Persian Gulf was severely degraded by a combination of factors including mountainous terrain, atmospheric pollution and temperature inversions. The situation was so bad that fighter combat patrols could not be controlled beyond 75 n miles (140 km).

DEPLOYMENT

The class is split equally between the Atlantic (13) and Pacific (14) Fleets, with two of the latter homeported at Yokosuka, Japan.

AEGIS DEVELOPMENTS

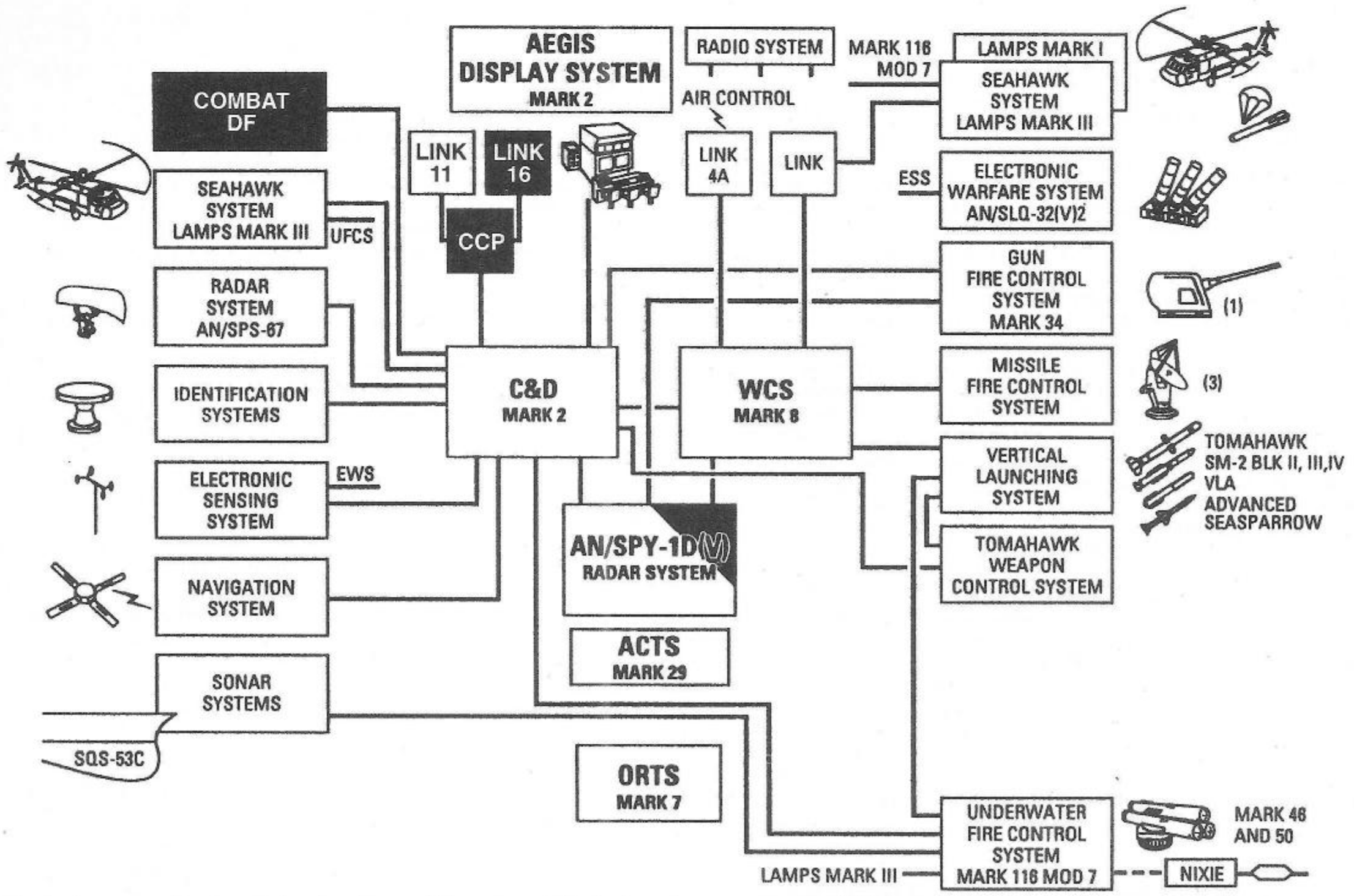
It is planned to improve Aegis to meet anti-ballistic missile (ABM) requirements, which would include adapting SPY-1 to enable it to concentrate radar energy automatically in specified sectors to increase both range and detection capabilities. During 1993 software modifications were conducted by the Combat System Engineering Development Site and the Johns Hopkins University's Applied Physics Laboratories.

In 1995 plans to integrate airborne radar data with the Aegis system began with experiments using a land-based system. The experiment is being extended in FY96/98 using an airborne radar platform and will be followed at the turn of the century by the integration of such a capability with new sensors and technology to create a theatre-wide technology demonstrator.

Other, lower level, plans exist to upgrade the systems in Baseline 2 cruisers to Baseline 2A standards. Proposals include replacing the AN/UYK-7 computers with the specially developed Unisys 'Aegis Backfit Computer' which is to UYK-43 standards but fits in the same cabinets. The ships may also receive new consoles or possibly the Advanced Display System.

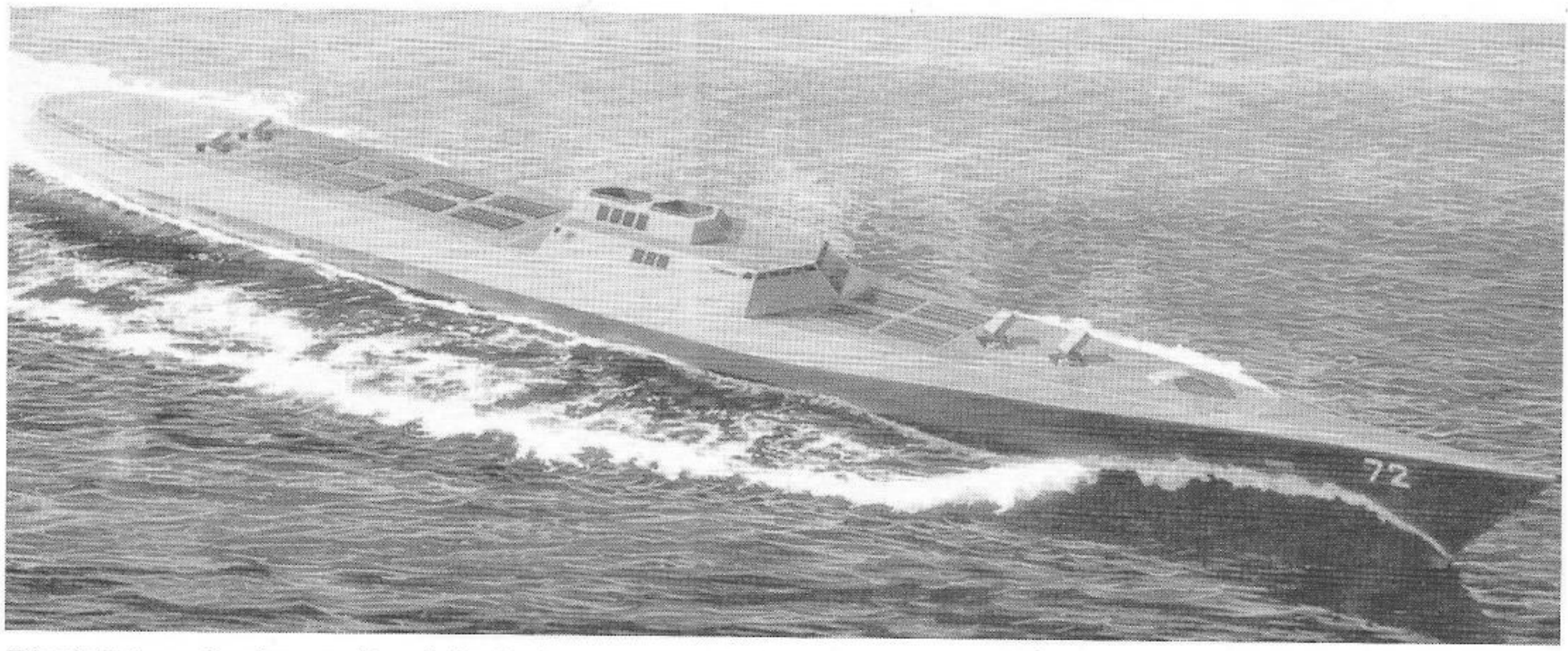
Other planned upgrades include Engineering Development Model 4B (EDM 4B), which involves improving the AN/SPY-1 radar signal processing and transmitter to operate in more confined waters to meet the new littoral warfare requirements. This will be introduced at the turn of the century.

As part of continuing trials, *Lake Champlain* (CG 57) fired the first SLAM missile from a Harpoon canister in June 1990, with the extended range SSM being controlled in terminal flight by a LAMPS III helicopter. In a separate trial, *Lake Erie* (CG 70) carried out trials of the Standard SM-2 Block IV in mid-1994.



The Aegis command and control system; the world's most sophisticated naval command system (US Navy)

ARSENAL SHIP



This artist's impression shows one idea of what the Arsenal Ship might look like. Note the low propile, carefully angled surfaces, large numbers of missile launchers, and large flight deck aft. This would have a displacement of some 20,000 t (Lockheed Martin Government Electronic Systems)

GENERAL SPECIFICATIONS

Operator: USA
Type: Arsenal ship

Built: 0
Active: 0
Ordered: (6)

Displacement:
full load: 40,000 t

Dimensions
Length: 245 m (804 ft)
Beam: 32 m (105 ft)
Draught: 9 m (30 ft)

Speed: 25 kts

Complement: 50

PROPULSION

Specifications
System: Gas turbines
Main machinery: 4 gas turbines

FURTHER INFORMATION

PROGRAMME

One of the most ambitious projects currently under consideration, the US Navy hopes to build and deploy six 'arsenal ships', with the first being completed in 2001. The project has, however, yet to be funded, and may be limited initially to a technology demonstrator.

The primary mission for these ships would be to carry some 500 missiles, all of existing types, to be used in support of land forces engaged in littoral operations. These would include the current range of navy missiles, supplemented by the US Army's ATACMS (Army Tactical Missile System).

DESIGN

The 'arsenal ship' would be approximately the same size as the 'Iowa' class battleships:

Another concept for the Arsenal Ship, this time from Bath Iron Works. This is a high-speed, wave piercing monohull but, again armed with large numbers of missile launchers. The shape makes an interesting comparison with that of Vosper Thornycroft's Sea Wraith *corvette (see Volume II: Corvettes)* (General Dynamics Bath Iron Works)

	'Arsenal ship'	'Iowa' class
Length	245 m (804 ft)	270 m (887 ft)
Beam	32 m (105 ft)	33 m (108 ft)
Draught	9 m (30 ft)	11.6 m (38 ft)

It would, however, seek to protect itself through a combination of stealthy design, electronic means and (possibly) the ability to use water ballast to reduce its freeboard in the operational area.

The missile launchers would be a mix of vertical tubes and twin-arm launchers, and, although not shown in current art work, there may also be several long-range guns of the types currently under development.

At the time of writing, several designs were under consideration, of which two would be new builds and two conversions. The new builds would be either a totally new design (as shown here) or a smaller and less expensive (and less capable) ship, based on a DDG 51 hull. The conversions under consideration involve either a TAO oiler hull or an 'Ohio' class submarine.

The Mission Need Statement includes a variety of requirements, such as:

- Full functionality in all adverse environments (for example, electromagnetic warfare; nuclear, biological and chemical fallout; severe weather) and resistance to the shock effects of nuclear and conventional weapon attack.
- Maximum standardisation or interoperability with joint and allied forces
- The ability to accommodate and replenish helicopters and UAVs (unmanned aerial vehicles)
- The ability to embark SOF (Special Operations Forces)
- The ability to transit through the Panama Canal.

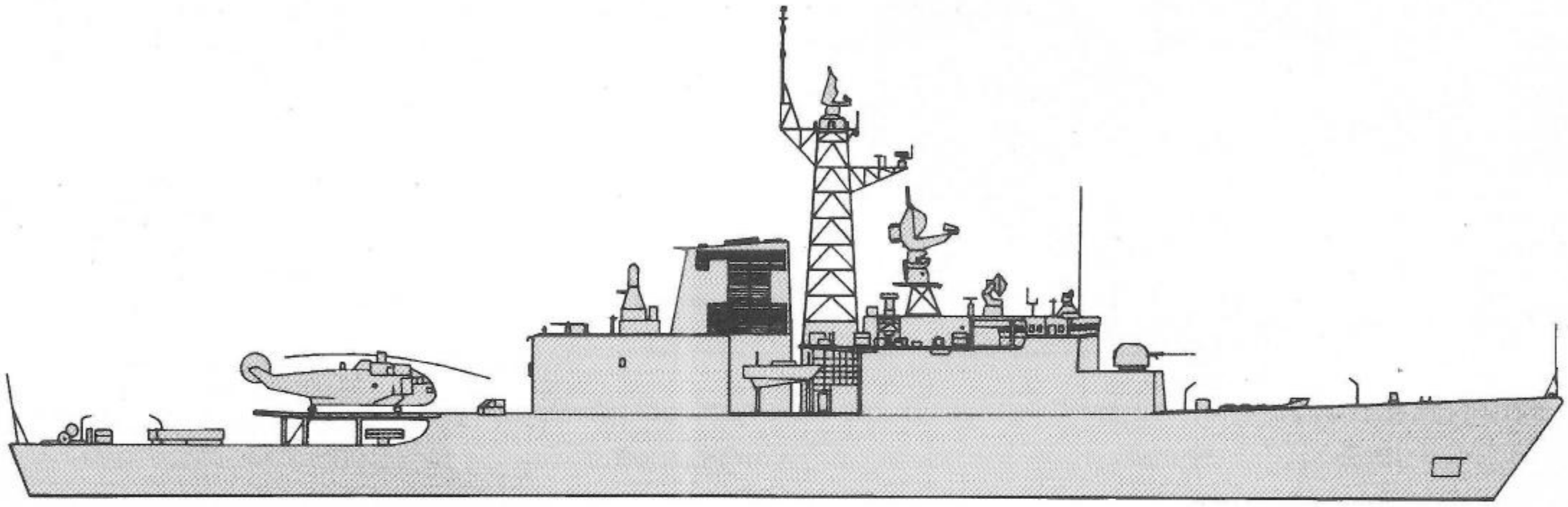
OPERATIONAL

These ships are essentially intended for fire support missions, and although vastly different in scale and capability, they appear conceptually similar to the Second World War 'monitors', which were designed for shore bombardment and armed with a small number of very large calibre guns. The British Second World War monitor, *Roberts,* for example, mounted a single twin 38 cm (15 in) gun turret on a hull displacing 9,500 t. The SC-21, however, will have a great variety of weapons with ranges taking them deep inland. Targeting would be carried out by other ships, aircraft (such as the ship's own helicopters and UAVs) or by the land forces themselves.

It is intended that manning will be minimal, possibly as few as 20, although such elementary factors as ship handling, maintenance and watch-keeping would suggest at least 50.

DESTROYERS (DD)

IROQUOIS



Iroquois (Ian Sturton)

GENERAL SPECIFICATIONS

Country of origin: Canada

Class: IROQUOIS

Built: 4
Active: 4

Displacement:
normal: 3,551 t
deep load: 5,100 t

Dimensions
Length: 121.4 m (398 ft) wl; 129.8 m (426 ft) oa
Beam: 15.2 m (50 ft)
Draught: 4.7 m (15.5 ft) keel; 6.6 m (21.5 ft) screws

Speed: 29+ kts
Range: 4,500 n miles at 20 kts

Complement: 255 (23 officers); plus aircrew 30 (11 officers)

SHIPS

(Note: TRUMP = TRibal class Update and Modernisation Project)

IROQUOIS (280)

Builder	Marine Industries Ltd, Sorel, Canada
Laid down	15 Jan 1969
Launched	28 Nov 1970
Commissioned	29 Jul 1972
TRUMP	Nov 1988 (MIL Davie, Quebec, Canada)
Recommissioned	May 1992

HURON (281)

Builder	Marine Industries Ltd, Sorel, Canada
Laid down	15 Jan 1969
Launched	3 Apr 1971
Commissioned	16 Dec 1972
TRUMP	Jun 1992 (MIL Davie, Quebec, Canada)
Recommissioned	Jan 1995

ATHABASKAN (282)

Builder	Davie Shipbuilding, Lauzon, Canada
Laid down	1 Jun 1969
Launched	27 Nov 1970
Commissioned	30 Sep 1972
TRUMP	Sep 1991 (MIL Davie, Quebec, Canada)
Recommissioned	Aug 1994

ALGONQUIN (283)

Builder	Davie Shipbuilding, Lauzon, Canada
Laid down	1 Sep 1969
Launched	23 Apr 1971
Commissioned	3 Nov 1973
TRUMP	Nov 1987 (MIL Davie, Quebec, Canada)
Recommissioned	Oct 1991

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Mk 41 Mod T GMVLS

There is a single Lockheed Martin Mk 41 Mod T Guided Missile Vertical Launch System (GMVLS) for Standard SM-2MR missiles, located under the foredeck. This has three 8-cell modules and one 5-cell 'strike-down' module, for a total of 29 missiles. Firing rate is reported to be about 1 missile per second.

Manufacturers/Contractors

Lockheed Martin Aero and Naval Systems, Baltimore, Maryland, USA (Overall system, electronics, software).
FMC Naval Systems Division, USA (launcher, canister).

Standard Missile 2 Medium Range (SM-2MR)

Following TRUMP, these four ships are now armed with Standard SM-2MR Block III, which can be used for surface-to-air and surface-to-surface engagements. The guidance assembly incorporates fast Fourier techniques in the signal processor and it possesses a passive home-on-jam capability. The propulsion section uses the Thiokol Mk 104 dual-thrust rocket motor with ARC acting as second source. This is a more powerful motor than its predecessor and it provides substantial improvements in speed and manoeuvrability as well as a 60 per cent increase in range.

The SM-2 missile's course is controlled from the ship by means of an RF link until the target comes within the missile seeker's field of view. This system allows the use of the ship's search radar to provide missile launch data and by shaping the missile flight path into an energy-efficient trajectory the effective range of the system is doubled.

Specifications

SM-2MR
Length: 4.72 m (15.49 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.06 m (3.47 ft)
Weight: 706.7 kg (1,558 lb)
Speed: Mach 2.5
Range: 37.75 n miles (70 km)
Altitude: 19,800 m (65,000 ft)
Guidance: Semi-active radar homing

Manufacturers/Contractors

Hughes Missile Systems, Tucson, Arizona, USA.
Raytheon Missile Systems Division.

TUBES

Two triple 324 mm US Mk 32 torpedo tubes are sited aft, under the flight deck, one on either beam.

Specifications

Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

Algonquin *(D 283) in its post-TRUMP form. Note the Mk 41 vertical launcher in the foredeck and the 76 mm gun before the bridge. The picture also shows the stern well, which is used to launch and recover the variable depth sonar* (Canadian Maritime Command)

TORPEDOES

Alliant Techsystems Mk 46 Mod 5 324 mm torpedoes

Specifications
Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507.0 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: Liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

GUNS

OTOBREDA 76 mm (3 in)/62 Super Rapid

There is one OTOBREDA 76 mm (3 in)/62 calibre Super Rapid gun in a single turret atop a box-like structure immediately forward of the bridge.

Specifications
Elevation: −15 to +85°
Training speed: 60°/s
Elevation speed: 35°/s
Muzzle velocity: 925 m/s
Rate of fire: 120 rds/min (3,034 ft/s)
Weight of shell: 6 kg (13.23 lb)
Range: 8.5 n miles (15.75 km)

Manufacturer/Contractor
OTOBREDA, La Spezia, Italy.

Hughes Mk 15 CIWS Phalanx

A single Hughes Mk 15 Phalanx close in weapons system (CIWS) is mounted on the roof of the hangar aft to provide the innermost layer of defence against anti-ship missiles. The 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun has a cylindrical magazine with the feed mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications
Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor
Hughes Missile Systems, Tucson, Arizona, USA (system).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

AN/SLQ-501 (CANEWS I) radar warning system

CANEWS is a real-time radar detection and analysis system, covering the frequency band 1-18 GHz in five bands, each with its own receiver. It has four major subsystems: an IFM-based (instantaneous frequency measurement) antenna and receiver subsystem; a data transfer unit incorporating a high-speed digital processor; twin processors for real-time analysis, supervision and interfacing with the ship's command and control system; and a display console. A library holds data on numerous radar modes and signatures, and analysis of the detected RF signals identifies the radar type and platform, as well as providing an indication of the confidence level. Many of the functions are automatic to reduce operator workload, but AN/SLQ-501 also provides facilities for manual control if required, with one operator only required to control the complete ESM system. Lockheed Canada is leading a consortium of Canadian EW companies to define and develop CANEWS II, which will retain existing antennas and receivers, but add a new processor and further receivers to handle more complex threats, higher signal densities and wider operating frequencies. CANEWS II was tested in 1994-95 and is undergoing sea trials in 1996.

Manufacturer/Contractor
Lockheed Canada Inc, Kanata, Ontario, Canada (prime (CANEWS II)).

AN/SRD-503

AN/SRD-503 is an intercept equipment.

ELECTRONIC COUNTERMEASURES (ECM)

AN/SLQ-30

SLQ-30 is a Canadian upgrade of the US-supplied AN/ULQ-6 deception jammer, which was developed especially for the TRUMP programme. There are two sets (one on either beam) in each ship and the system is designed to generate a false target and reacts automatically to specified threats.

DECOYS

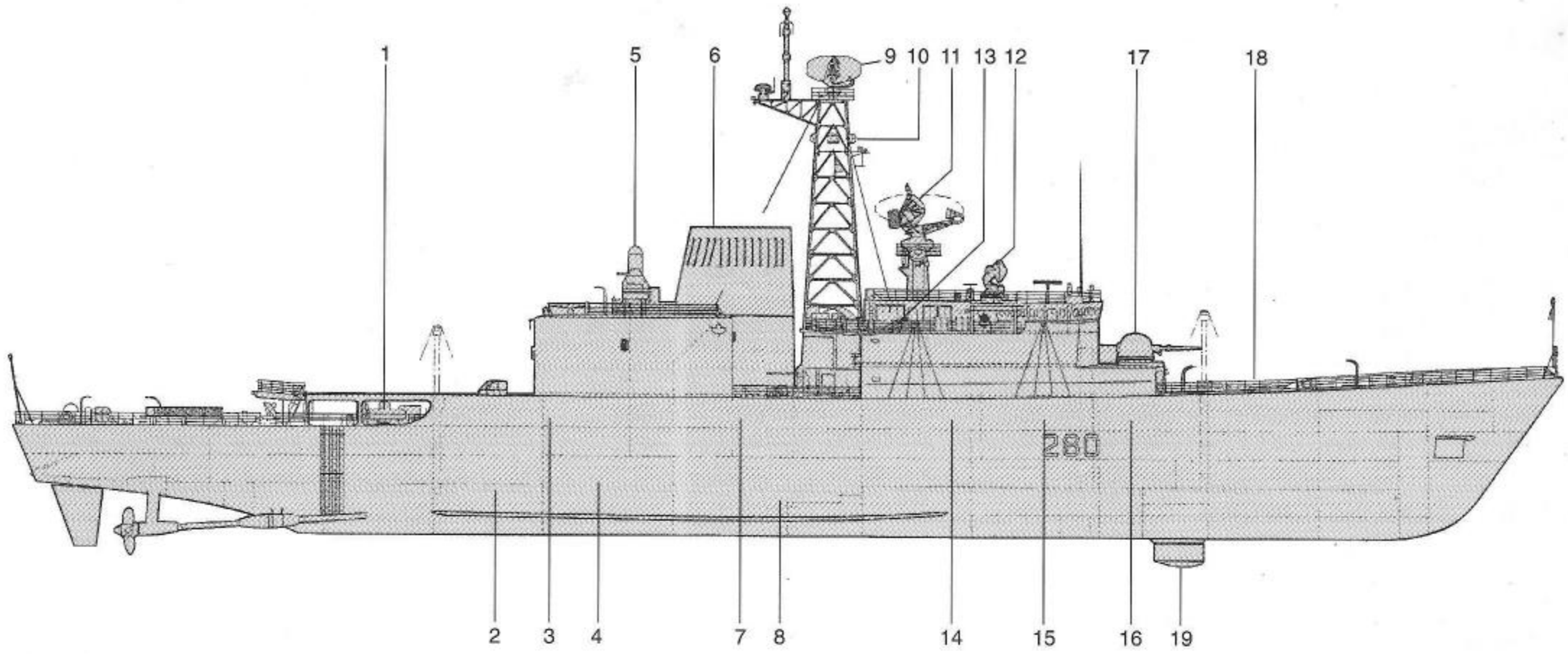
Plessey Shield Tactical Decoy System

There are two launchers, each with six parallel barrels, for the Plessey Shield system, sited on either beam, just forward of the mast. Shield is a microprocessor-controlled, fully automatic missile decoy system, which is designed to provide effective protection for various sizes of ship, including fast attack craft, corvettes, frigates and destroyers. On detecting a threat, Shield selects the most appropriate response from up to six million scenarios held in its EPROM memory, using data obtained from onboard sensors such as radar and ESM and then automatically deploys the pattern of decoys that will give the highest probability of success. GEC-Marconi chaff rockets are fitted with a variable fuze which allows the chaff to be dispersed at optimum positions along the trajectory. To counter threats with a dual-mode capability, both chaff and infra-red decoys can be deployed automatically. Shield offers four protection modes — confusion; distraction; seduction/breaklock; and seduction dump — and uses two types of decoy — chaff and infra-red — which may be used on their own, or in combination with each other.

Manufacturer/Contractor
GEC-Marconi Naval Systems, Addlestone, UK.

AN/SLQ-25 Nixie torpedo decoy

One AN/SLQ-25 Nixie (Phase 1), solid-state, modular design electroacoustic countermeasures decoy system is used to protect the ship from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for



The 'Tribal' class Update and Modernisation Project (TRUMP)
1 *Torpedo tubes retained, but handling and stowage improved* **2** *New diesel generator; 1,000 kW* **3** *Air conditioning upgraded* **4** *New cruise engines (GM-Allison 570-KF gas-turbines) fitted* **5** *Mk 15 Phalanx CIWS fitted* **6** *Totally new stack with IR suppression fitted* **7** *SHINMACS, a completely new and comprehensive machinery control system fitted* **8** *Previous flume-type anti-roll tanks replaced by a water displaced fuel system* **9** *SPS-501 air search radar replaced by Signaal LW-08* **10** *CANEWS (AN/SLQ-501) radar detection and analysis system installed* **11** *SPQ-2D surface search/navigation radar replaced by Signaal DA-08* **12** *Signaal M22 fire-control system replaced by Signaal STIR 1.8* **13** *Plessey Shield decoy system installed* **14** *New inertial navigation system installed* **14** *SHINPADS (SHipboard INtegrated Processing And Display System) installed* **16** *SHINCOM interior communications system installed* **17** *127 mm gun replaced by OTOBREDA 76 mm Super Rapid* **18** *Mk 41 vertical launch system installed; Standard SM-2MR* **19** *Existing sonar retained, but upgraded and integrated into SHINPADS*

streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 488 m (1,600 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 95 cm (3.10 ft) long, 15.24 cm (6 in) in diameter and weigh 18 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body at a time is deployed.

Manufacturer/Contractor

Aerojet ElectroSystems, Sacramento, California, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

AN/UYC-501 (V) SHINPADS (SHipboard INtegrated Processing And Display System)

SHINPADS is an automated command and weapon control system with a distributed architecture, which is based on up to 18 32-bit computers using CMS-2M software language. Links within the ship use the SHINPADS Serial Databus, which has a data transfer rate of 9.5 Mbits/s and a clock rate of 10-12 MHz. Earlier systems use the Unisys AN/UYK-504 (a licence-produced AN/UYK-20 mini-computer) but with an embedded SHINPADS node for interfacing with the system; UYK-504 has a memory of 256 k and an operating speed of 240 Kops. *Montreal* and later ships have the upgraded AN/UYK-507 computer, using replacement cards and with a minimum memory of 256 k static RAM (random access memory), expandable to 512 k, which can be further expanded to 8 M in dynamic RAM. The operating speed of the UYK-507 is 5 Mips.

SHINPADS normally has 14-15 workstations including a bridge display and in the combat direction centre (CDC) there are workstations for the commanding officer, operations room officer, the sensor weapons controller (SWC) and assistant SWC.

Canadian destroyer Iroquois *(D 280) in its original state with bifurcated funnel, 127 mm gun, twin M22 fire-control radars (in 'eggs') and SPS-501 air search radar. The ship was the first to be commissioned in 1972 and the second to undergo the TRUMP modernisation between November 1988 and May 1992* (Canadian Maritime Command)

Manufacturers/Contractors

Unisys GSG Canada Ltd, Montreal, Canada (prime contractor).
Computing Devices Canada, Nepean, Ontario, Canada (subcontractor).

COMMUNICATIONS AND DATALINKS

Link 11
Link 14
WSC-IV Satcom
SSR-1 Satcom
JOTS II
Tacan: URN 26

WEAPONS CONTROL

Signaal LIROD 8 optronic director

LIROD (Lightweight Radar Optronic Director) is a lightweight fire-control system based upon a K-band tracking radar and a TV camera, and is designed for simultaneous control of two dual-purpose guns while tracking one air and one surface target. The system reaction time from detection to the beginning of the engagement is about 4.5 seconds. It is based upon a 0.6 m (1.97 ft) diameter parabolic antenna with monopulse cluster. It has a very narrow pencil beam and is resistant to clutter through the application of pulse Doppler tracking combined with FFT techniques. There are also sophisticated ECCM facilities. The radar can track fighter-size targets up to 18 km away and is capable of tracking targets with a maximum speed of 1,000 m/s (3,280 ft/s). In addition to the radar there is a militarised TV camera with CCIR standard video format, which can detect fighter-size targets at about 5.44 n miles (10 km) and large surface ships at about 10.9 n miles (20 km).

Specifications

Director
Traverse: 360°/s at 120°/s
Elevation: −25 to +150° at 80°/s
Radar: K-band

Field-of-view:
TV camera: 3-30° (2-20°)
IR camera: 3°

Laser rangefinder
Pulse length: 20 ns
Max repetition frequency: 10 Hz
Beam divergency: 1.2-1.5 mrad

Laser tracker
Max repetition frequency: 25 Hz
Beam divergency: 1.5 and 6 mrad

Manufacturer/Contractor

Hollandse Signaalapparaten BV, The Netherlands.

RADARS

Set	SPQ-502 (LW 08)	SPQ-501 (DA 08)	SPG-501 (STIR 1.8)	AN/SPS-64 (Pathfinder) (two sets)
Company	Signaal	Signaal	Signaal	Raytheon
Role	Air search	Surface search/target indication	Fire control	Navigation
Band	D	E/F	I/J/K	I/J
Range	145 n miles for 2 m² target at 85,000 ft	92 n miles	76 n miles (140 km)	18.3 m-118.5 km
Beam	2.2 × csc² to 40°	1.5 × csc² to 40°	1.4°	1.25 × 20° *
Peak power	150 kW	145 kW	220 kW	10/25/50 kW
Gain	30 db	33 dB	—	—
Pulsewidth	35/69 µs	35/69 µs	0.29 µs	0.06/0.5/1 µs
PRF	1,000/500 pps	1,000/500 pps	1,800/3,600 pps	3,600/1,800/900 pps
Scan rate	7.5/15 rpm	10/20 rpm	—	28 rpm

* Depends on size of antenna

SONARS

AN/SQS-505(V)6 hull-mounted sonar and VDS search and attack sonar

The TRUMP ships are fitted with two identical sets of the AN/SQS-505 (V)6 search and attack sonar; one set is in a retractable, hull-mounted dome, the other is in a variable-depth 'fish'. The AN/SQS-505(V)6 is a deep water, omnidirectional, sonar surveillance system, but can also be operated in a directional mode when tracking a defined target. There are three selectable frequencies to enable several ships to operate in close proximity without cross-talk. In high sea states which result in excessive roll and pitch of the ship, the AN/SQS-505(V)6 utilises transmit beam stabilisation, which

Algonquin (D 283). *Sensors include two STIR 1.8 fire-control radar/illuminators (on bridge roof); LW-08 air search radar (atop small tower on bridge roof); and DA-08 surface search radar (at mast head). All are produced by Dutch electronics company, Signaal* (H & L van Ginderen Collection)

Algonquin *(D 283) on NATO Operation Sharp Guard in August 1993* (NATO/HQ AFSOUTH)

delays transmission until near optimum roll and submergence conditions prevail, in order to minimise the chances of the target being missed altogether. The (V)6 differs from earlier versions in having a new transmitter and receiver, and is designed specifically to work with SHINPADS.

Specifications

Coverage: 360° (azimuth)
Range: 183-975 m (200-3,200 yd)
Doppler range: ±40 kts (7.2 kHz)
Displays: Range (A Scan); Bearing (B Scan); Doppler
Frequencies:
active: 6.4 kHz, 7.2 kHz, 8.0 kHz
passive: 4.5 kHz
Source levels: From 224.233 dB/µPa/m (transmission mode dependent)
Initial detection: 12 ping history of returns
Bearing accuracy: 1 RMS
Range accuracy: ±1 per cent range reading
Transmission modes: Omni, TRDT, DT, ASPECT

Manufacturer/Contractor

Westinghouse Canada Inc, Burlington, Ontario, Canada.

Westinghouse AN/SQS-501

The Westinghouse AN/SQS-501 is the Canadian version of the British Kelvin Hughes Type 162 ('Cockchafer') side-looking target detection sonar, whose main use is in detecting and classifying seabed targets, such as a bottomed submarine. There are three transducers: one faces downwards at 25° below the horizontal, while the other two face sideways to cover a 3° wide and 40° vertical sector. The transmitter delivers 40 W to the central, downward-looking transducer and 80 W each to the side-looking transducers. The set operates at 50 kHz and accuracy is <2 percent over ranges of 270 m (300 yd) and 550 m (600 yd).

Manufacturer/Contractor

Westinghouse Canada Inc, Burlington, Ontario, Canada.

Computing Devices UYS-503(V) sonar processor

UYS-503(V) is the processor for the SQS-510 and SQS-501 sonars

AVIATION

AVIATION FACILITIES

Flight deck

There is a large hangar which accommodates two CH-124A Sea King helicopters. There is also a large flight deck with a RAST hauldown device.

HELICOPTERS

Two CH-124A Sea King ASW.

Specifications

Main rotor:
diameter: 18.90 m (62.0 ft)
disc area: 280.5 m² (3,019 sq ft)
Length overall (both rotors turning): 21.91 m (71.88 ft)
Weight, empty: 5,601 kg (12,350 lb)
Max take-off weight: 9,525 kg (21,000 lb)
Max speed (never exceed): 144 kts (267 km/h)
Typical cruising speed: 110 kts (204 km/h)
Service ceiling: 3,720 m (12,200 ft)
Range with max standard fuel: 410 n miles (760 km)
Power plant: 2—1,118 kW (1,500 shp) General Electric T58-GE-100 turboshafts
Fuel: Normal fuel capacity 3,180 litres (840 US gallons)
Accommodation: Crew of 4 in ASW role (pilot, co-pilot, two sonar operators)
Sensors
ASW role: APS-503 radar; sonobuoys; ASQ-13 dipping sonar; radio altimeter; marine markers, smoke floats. FLIR and EW equipment can also be installed, according to requirements
Weapons: Maximum of 4 Mk 46 torpedoes

PROPULSION

Specifications

System: COGOG (COmbined Gas Or Gas)
Main machinery: 2 Pratt & Whitney FT4A2 gas turbines; 37 MW (50,000 hp); 2 GM Allison 570-KF gas turbines; 9.5 MW (12,700 hp) sustained
Shafts: 2
Props: cp

FURTHER INFORMATION

PROGRAMME

The Canadian 'Tribal' class destroyers had their origin in a 1960 project for eight general purpose frigates, displacing some 4,700 t at full load, and which would have been armed with a single RIM-24 Tartar SAM system, a 127 mm (5 in) gun and ASW torpedo tubes. This project was shelved in 1963 without an order having been placed, but the hull design was later used for the 1968 'Tribal' class destroyer project.

Four Tribals were built between 1969 and 1973 and were amongst the best-equipped ASW ships in any navy. In 1986, however, authorisation was obtained for a complete rebuild of the ships to convert them into anti-air warfare (AAW) ships, to meet a long-standing requirement for the Canadian Navy.

This programme, known as TRUMP (Tribal Update and Modernisation Programme) started with *Algonquin* in 1987-91, followed by *Iroquois* (1988-92) and was completed when *Huron* and *Athabaskan* returned to the fleet in 1993.

DESIGN

These ships were built as ASW ships for employment in northern waters. For this mission they carried two Sea King ASW helicopters and were armed with British Mk 10 Limbo mortars and two sets of triple 324 mm torpedo tubes. Three sonar sets were mounted: SQS-505; SQS-505(VDS) and SQS-501. Secondary armament included a 127 mm gun and the Sea Sparrow short-range system, with two launchers and the magazine housed in a large box immediately before the bridge.

They were also fitted with a pre-wetting system to counter NBC conditions, an enclosed citadel, and bridge control of machinery. Two Sea King helicopters were carried, which were considered by many other navies to be too large for this size of ship at the time they entered service.

These were the first Western destroyers to be built with an all-gas-turbine propulsion system, with two cruise and two boost engines mounted side by side, and both engines and gear systems were mounted on rafts. Stabilisation was achieved by a passive tank system, another measure to reduce the acoustic signature.

MODERNISATION

The Canadian Navy had long required an AAW design and the TRUMP contract for such a conversion was awarded to Litton Systems Canada Limited in June 1986. The new equipment reflects the changing role of the ship and replaced systems that did not meet the air defence requirement.

The primary weapons system is now the Standard SM-2MR SAM, with a 41 vertical launch system installed under the foredeck in the space previously occupied by the 127 mm gun and its magazine. That gun has been replaced by the much smaller and lighter OTOBREDA 76 mm Compact, while a new Phalanx 15 20 mm CIWS has been installed on the hangar roof.

Other changes include replacing the flume-type anti-roll tanks with a water-displaced fuel system and a more conventional stack in place of the earlier and rather ugly bifurcated uptake. Somewhat ominously, the design weight limit has now been reached, so the scope for yet further improvements is now very limited.

Helicopter replacement

The CH-124A Sea Kings were to have been replaced by EH 101 Merlins, but the programme was cancelled by the Canadian Government at considerable cost. Meanwhile, the CH-124 has been in service for a long time and is still in urgent need of replacement and the Canadian Navy is again looking for a replacement.

TABLE 1: WEAPONS

	Original Tribal	After TRUMP
AAW		
Launcher	2 × launchers	1 × 41 VLS
Missile	Canadian Sea Sparrow	Standard SM-2MR
Guns	1 × 127 mm	1 × 76 mm
	–	1 × 20 mm CIWS
ASW	10 Limbo mortar	–
TT	6 × 324 mm Mk 32 tubes	6 × 324 mm Mk 32 tubes
Helicopter	2 × Sea King	2 × Sea King

The sensor fit has also been updated, with obvious emphasis on the AAW mission:

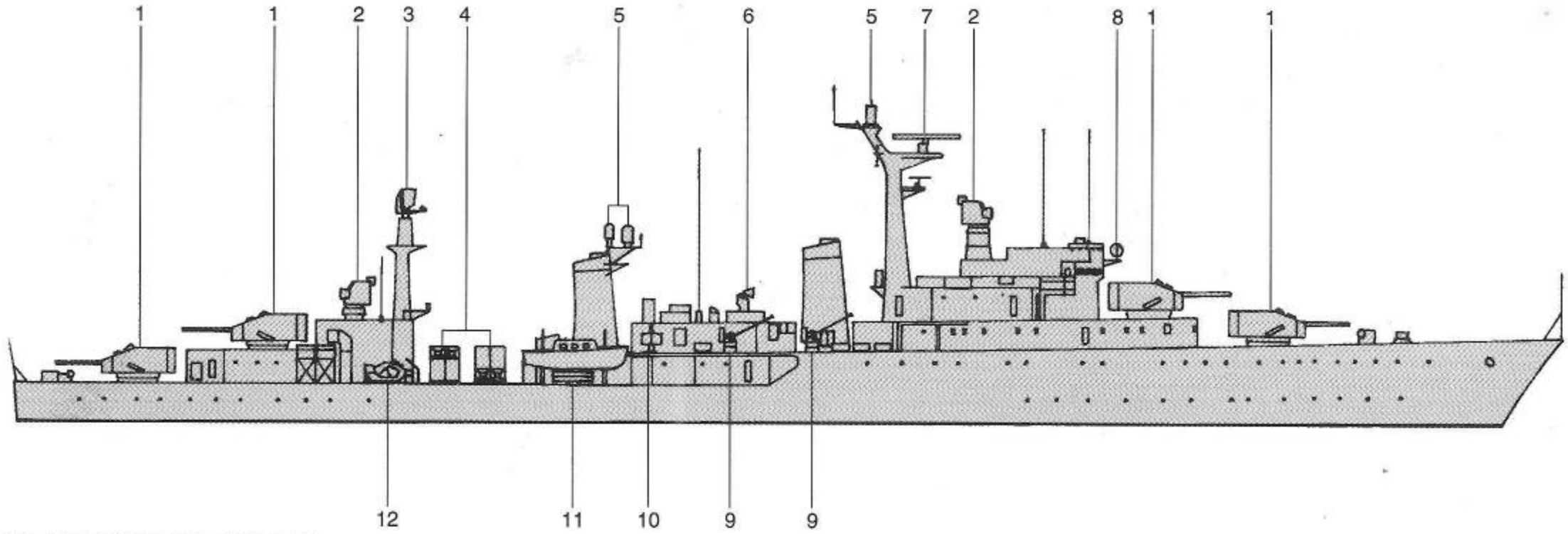
TABLE 2: SENSORS

Sensors	Function	Original Tribal	After TRUMP
Radar	Air search	SPS-501	Signaal LW 08
	Surface search/ navigation	SPQ-2D	Signaal DA 08
	Fire control	HSA M22	Signaal STIR 1.8
Sonar	Hull-mounted	SQS-505	SQS-510
	VDS	SQS-505(VDS)	SQS-510
	Bottom target classification	SQS-501	SQS-501
	Mine detection	–	Spectra 3000

OPERATIONAL

Algonquin and *Huron* are based in the Pacific, *Iroquois* and *Athabaskan* in the Atlantic. All are scheduled to remain in service until at least 2005.

ALMIRANTE RIVEROS



Almirante Williams (Ian Sturton)

1 *102 mm (4in) Vickers Mk (N)R single gun mounts* **2** *SGR 102 fire control (guns)* **3** *AWS-1 air search radar* **4** *MM 38 Exocet launcher (four)* **5** *Radomes (unknown identity)* **6** *Signaal M4/3 (Seacat SAM fire control)* **7** *SNW-10 radar (air/surface search)* **8** *Direction-finding (DF) antenna* **9** *Bofors 40 mm/70 AA guns* **10** *Seacat SAM launcher* **11** *Mk 32 324 mm triple torpedo tubes* **12** *Admiralty pattern Squid ASW mortars*

GENERAL SPECIFICATIONS

Country of Origin: UK
Operator: Chile

Class: ALMIRANTE RIVEROS

Built: 2
Active: 1

Displacement:
standard: 2,730 t
full load: 3,300 t

Dimensions
Length: 122.5 m (402 ft)
Beam: 13.1 m (43 ft)
Draught: 4 m (13.3 ft)

Speed: 34.5 kts
Range: 6,000 n miles at 16 kts

Complement: 266 (17 officers)

SHIPS

ALMIRANTE WILLIAMS (19)

Builder	Vickers-Armstrong Ltd, Barrow-in-Furness, Cumbria, UK	**Laid down**	20 Jun 1956
		Launched	5 May 1958
		Commissioned	26 Mar 1960

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Exocet MM 38 medium-range anti-ship missile

Four Aerospatiale MM 38 Exocets are mounted immediately abaft the after stack in individual ITS *(Installation de Tir Standard)* launcher-containers, within which they are suspended from a launch rail in the ceiling. These launcher-containers point outwards and are inclined at an angle of 12° to the horizontal. Targets are acquired by the ship's search radar and the operator then aligns the axial gyros in the target's direction and begins the initiation sequence. This involves turning on the thermal battery, releasing the mechanical safety locks, igniting the booster and, finally, breaking the umbilical cord; the total process takes some 60 seconds. Exocet has a 105° off-axis engagement envelope and can perform one 15° change of course during its flight.

The attack consists of three phases:

Cruise phase. The cruise phase starts as the missile clears the container and, powered by the sustainer motor, flies towards the general location of the target at a height of about 100 m which is low enough to reduce the chance of detection but adequate for target acquisition. This phase can be as long as 22 km and ends when the seeker acquires the target. This seeker is a Dassault Electronique ADAC (Auto Directeur Anti-Clutter) active monopulse radar, working in the I-band (8-10 GHz), which has a typical range of 13 n miles (24 km) against FACs.

Approach phase. On detecting the target the missile descends to 9-15 m in the approach phase.

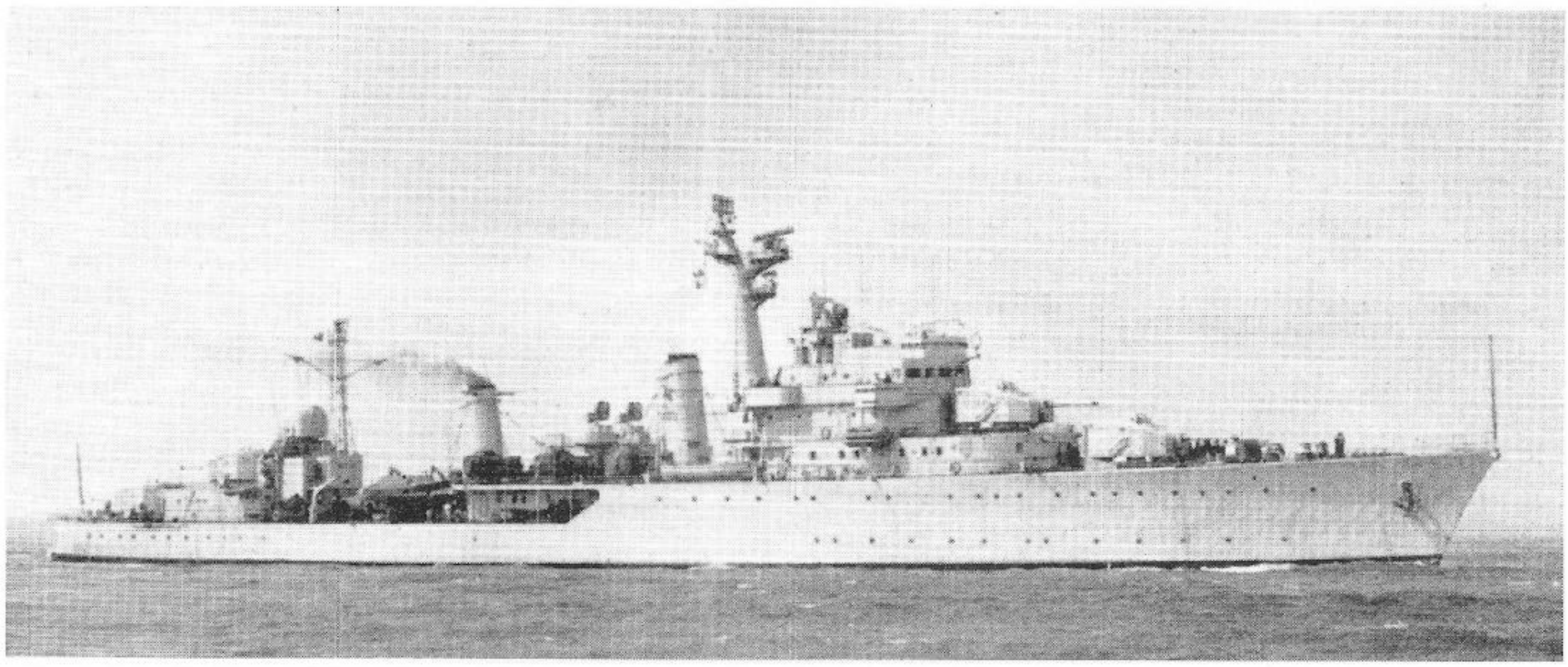
Terminal phase. During this final phase the missile descends to 8 m (2-5 m in a calm sea) for a sea-skimming run to the target.

A salvo may be fired in 12-20 seconds.

Almirante Williams, *the last remaining ship. Not visible in this picture are the four MM 38 Exocet launcher containers which are mounted abaft the after stack. The ship appears to have a large number of small radomes (on stacks and at foremasthead) which may be for ESM/ECM purposes* (Chilean Navy)

Specifications
MM 38
Length: 5.21 m
Diameter: 35 cm
Wing span: 1.00 m
Weight: 735 kg
Speed: Mach 0.9

Range: 2-22.5 n miles (4-42 km)
Guidance: Inertial and active radar
Sustainer motor: SNPE Eole alloy-cased CDB; weight 151 kg (333 lb); max burn time 93 s
Booster: 100 kg SNPE Epervier boost motor, burn time of 2.4 s
Warhead: Luchaire 165 kg fragmentation warhead



Almirante Riveros *in its original state in the early 1960s. These two destroyers were designed specifically for the Chilean Navy and the unique Vickers 102 mm (4 in) guns are only mounted in this class. The design was probably one of the finest of the traditional British destroyers* (Jane's)

Fuzes: Delayed impact fuze and autopilot-controlled proximity fuze

Manufacturer/Contractor

Aerospatiale Tactical Missiles, Chatillon Cedex, France.

SURFACE-TO-AIR MISSILES (SAM)

Short Seacat GWS.22

There are two Short Seacat GWS.22 quadruple launchers in the waist. 16 reloads are carried.

Specifications

Missile
Length: 1.48 m
Diameter: 19 cm
Wing span: 65 cm
Weight: 68 kg
Speed: Mach 0.8
Range: 2.7 n miles (5 km)
Radar: Type 904 (see radar table (below))

Manufacturer/Contractor

MSI-Defence Systems (formerly Short Brothers plc), Belfast, UK.

TUBES

Six 324 mm US Mk 32 torpedo tubes are sited in two triple mounts either side of the after stack.

Specifications

Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

Manufacturer/Contractor

GEC-Marconi Naval Systems Inc, UK.

TORPEDOES

Honeywell 44 Mod 1 324 mm torpedoes

Specifications

Length: 2.56 m (8.4 ft)
Diameter: 324 mm (12.75 in)
Weight: 233 kg (514 lb)
Warhead: 34 kg (75 lb) HE
Speed: 30 kts
Range: 3 n miles (5.5 km)
Homing: Active acoustic homing
Max depth: 300 m (approx)

GUNS

Vickers 102 mm (4 in)/60 (N)R

Four Vickers 102 mm (4 in)/60 (N)R. This was a new, automatic single 102 mm (4 in) mounting, developed by Vickers specifically for this class of Chilean ships.

Specifications

Calibre: 102 mm
Length of barrel: 60 calibres
Max elevation: 75°
Muzzle velocity: 900 m/s (2,950 ft/s)
Rate of fire: 40 rds/min
Max range:
anti-surface: 10 n miles (18 km)
anti-air: 12,000 m (39,000 ft)
Weight of shell: 16 kg (35.3 lb)

Bofors 40 mm/70

Four Bofors 40 mm guns are installed in single mounts in the waist.

Specifications

Traverse: 360° (nominal) at 90°/s
Elevation: -3 to +85° at 60°/s
Rate of fire: 300 rds/min
Muzzle velocity: 1,005-1,025 m/s (3,297-3,363 ft/s)
Max range:
anti-surface: 6.5 n miles (12 km)
anti-air: 2.2 n miles (4,000 m)
Ammunition weight: 2.4 kg (5.29 lb)
Projectile weight: 0.96 kg (2.11 lb)
Crew: 4

ANTI-SUBMARINE MORTARS

Squid

Almirante Williams' principal ASW weapons are two British Admiralty-pattern Squid mortars, which are located either side of the main mast. Squid is a triple barrelled, 304.8 mm (12 in) mortar, the barrels being held in a vertical line within a steel frame which can be turned vertically from 0 to 90°. The weapon may be trained to cover a horizontal angle of about 30°, although it is usually deployed to fire straight ahead of the ship. The weapon is loaded and trained manually, with the ship's sonar providing the submarine location to a predictor, which computes the mortar aiming point. When the target reaches a predetermined point the depth recorder automatically sets the clockwork time fuzes and then launches the projectiles, which land in a triangular pattern with 37 m (40 yd) sides and where two Squids are embarked the patterns are set with 18 m (20 yd) difference. Squid is somewhat dated, having entered service in 1943 and having been installed in the last British ship in 1959.

Specifications

Weight: 10 t
Range: 250 m (829 ft)
Calibre: 304.8 mm (12 in)
Projectile: 177 kg (390 lb)
Explosive: 94 kg (207 lb) minol

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

WLR-1

WLR-1 is a US-manufactured, manually operated, radar warning system covering frequencies from 50 MHz to 10.75 GHz, employing a number of separate antennas.

Elta IR sensor

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Ferranti action data with autonomous displays.

WEAPONS CONTROL

Two Signaal M-4 directors for Seacat SAMs.

SONARS

Type 184 B sonar

The Type 184 B is a British active/passive search and attack sonar system, using a circular 32-stave transducer array 1 m (3.5 ft) in diameter and 1 m high in a retractable, keel-mounted dome. It operates at 6, 7.5 and 9 kHz with pulse lengths of 45 ms and 75 ms.

Manufacturer/Contractor
Graseby Marine (Graseby Dynamics Ltd), Watford, UK.

Type 170 sonar

Type 170 is the sonar used to control the Squid ASW mortar.

The transducer operates at high frequency (15-25 kHz) and operating limits are about 1,800 m (6,000 ft) in range and about 400 m (1,300 ft) in depth. Accuracy is about 0.5° in bearing and about 5 m (16 ft) in range.

Manufacturer/Contractor
Graseby Marine (Graseby Dynamics Ltd), Watford, UK.

RADARS

Set	AWS-1	SNW-10	1629	M2 (SGR-102)	M4/3 (SGR-108) (two)
Company	Plessey	GEC-Marconi	Racal-Decca	Signaal	Signaal
Role	Air search	Air/surface search	Navigation	Gun fire control	Seacat fire control
Band	D/E	E/F	I	H/I	I/J
Range	60 n miles (110 km)	—	—	24,000 m	—
Beam	1.5 × 40°	19°	1.3 × 23°	4.5°	—
Peak power	750 kW	450 kW	25 kW	180 kW	—
Gain	32 dB	—	30 dB	—	—
Pulsewidth	0.35/1.5 µs	3.8 µs	0.05/0.25/1.0 µs	0.2 µs	0.5 µs
PRF	1,000/400 pps	250/500 pps	1,300/650 pps	2,000 pps	1,600 pps
Scan rate	10/20 rpm	10 rpm	25 rpm	—	—

PROPULSION

Specifications
System: Steam turbines
Main machinery: 2 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 Parsons Pametrada turbines; 40 MW (54,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The two ships of this class, *Almirante Riveros* (D 18) and *Almirante Williams* (D 19) were ordered by the Chilean Navy from the British shipbuilders, Vickers-Armstrong, in 1955. They were completed in 1958 and joined the Chilean fleet in 1960. Short Seacat SAMs were installed in 1964 in place of two 40 mm mountings and both underwent significant modernisation in the UK in 1971-75. *Almirante Riveros* has been offered for sale, but it would seem more likely that it will be cannibalised to keep the other ship in service.

DESIGN

These ships were ordered at a time when most other South American navies were receiving surplus ships of Second World War vintage from either the UK or the USA and the Chilean Navy was thus able to obtain a 'state-of-the-art' design. Vickers based the overall design on that of the British Navy's Daring class, but with numerous differences to suit the customer. The hull is very similar to that of the 'Darings' but some 3 m (9 ft) longer, while the superstructure is more balanced and the general appearance is better.

The main armament comprises four 4 in (102 mm) DP (dual-purpose) guns in single mountings, which were developed specifically for this class, based on recent work done by Vickers on a 105 mm anti-aircraft mounting for the British Navy. Anti-aircraft defences were strengthened by six single Bofors 40 mm guns which were concentrated in the waist on a platform deck. Finally, ASW armament consisted of five 533 mm (21 in) torpedo tubes and two Squid mortars. Contemporary radars and sonars were also fitted.

MODERNISATION

The first major change came in 1964, when two quadruple launchers for the British Seacat SAM were installed, replacing two 40 mm mountings. Later, a major modernisation was carried out in 1971-74; this was done in the UK by Swan Hunter in co-operation with Plessey. This included fitting four MM 38 Exocet SSM launchers, displacing the quintuple torpedo tubes between the after stack and the mainmast, and the addition of two triple Mk 32 torpedo tubes, one set on either beam, under the platform deck.

In 1980 four Exocet launchers, two from each ship, were transferred to other destroyers in the Chilean Navy, although the number in the 'Almirante Riveros' class ships has since been restored to its original four.

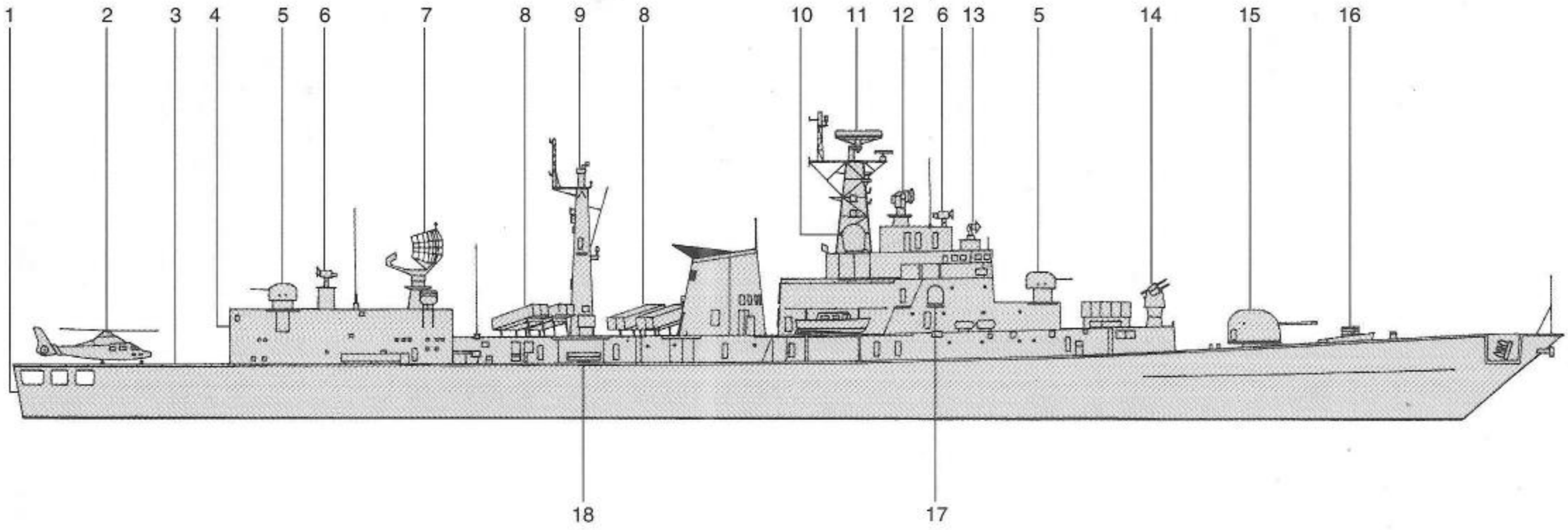
In the late 1980s both ships were given a further extensive refit, with the addition of modern electronic equipment including Netherlands M4 fire-control radars and additional ESM equipment was fitted in 1990.

A plan to replace the elderly Seacat launchers with Israeli Barak seems to have been put in abeyance. The 102 mm (4 in) turrets were removed one at a time during the late 1980s to be refurbished, but the ships remained operational.

FUTURE

Almirante Riveros has been on offer for sale for some time, but there have been no known bids. It appears likely, therefore, that it will be cannibalised for spares to keep *Almirante Williams* in service for a few more years.

LUHU



Haribing (Ian Sturton)
1 *VDS* **2** *Harbin Haitun (licence-built Dauphin) helicopter (two)* **3** *Flight Deck* **4** *Hangar* **5** *37 mm/63 twin mounting* **6** *EFR-1 (Rice Lamp) fire director (for 37 mm)* **7** *Hai Ying (God Eye) radar (air search)* **8** *YJ-1 (Eagle Strike) (C-801) anti-ship missiles* **9** *ESR-1 radar (surface search)* **10** *Satcom* **11** *Thomson-CSF TRS-3004 radar (air/surface search)* **12** *Type 347G fire controller (missiles, 100 mm gun)* **13** *Thomson-CSF Castor II fire director (Crotale SAM)* **14** *Thomson-CSF Crotale SAM octuple launcher* **15** *100 mm (3.9 in)/56 twin gun mounting* **16** *FQF-2500 ASW mortar (two)* **17** *BM 610 ESM antenna (two)* **18** *Whitehead B-515 triple 324 mm torpedo launcher (two)*

GENERAL SPECIFICATIONS

Operator: China, People's Republic
Type: Type 052

Class: LUHU

Building: 2
Active: 2
Proposed: 2 (?)

Displacement:
full load: 4,200 t

Dimensions
Length: 142.7 m (468.2 ft)
Beam: 15.1 m (49.5 ft)
Draught: 5.1 m (16.7 ft)

Speed: 31 kts
Range: 5,000 n miles at 15 kts

Complement: 230 (40 officers)

SHIPS

HARIBING (112)	
Builder	Jiangnan Shipyard
Laid down	1988
Launched	Jun 1991
Commissioned	Jul 1994

QINGDAO (113)	
Builder	Jiangnan Shipyard
Laid down	1991
Launched	Oct 1993
Commissioned	Mar 1996

—	
Builder	Jiangnan Shipyard
Laid down	1995
Launched	Oct 1997
Commissioned	1999

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Ying Ji (Eagle Strike) YJ-1 (C-801) missiles

There are eight launchers for Ying Ji YJ-1 (C-801) SSMs. These are mounted in two groups of four. The forward group, located between the stack and the mainmast, face to port and the second group, facing to starboard, abaft the mainmast. The YJ-1 is rocket-propelled with a rocket booster, and on launch it climbs to about 50 m (160 ft) then descends to 20 to 30 m (66 to 100 ft) until its radar seeker has acquired the target. It then descends to 5 to 7 m (16 to 23 ft) using the nose-mounted, monopulse (probably J-band) radar seeker for the terminal approach phase.

Specifications

Length: 5.81 m (19.06 ft)
Diameter: 36 cm (14.17 in)
Wing span: 1.18 m (3.87 ft)
Propulsion: Rocket motor
Weight: 815 kg (1,797 lb)
Range: 4.5-23 n miles (8-42 km)
Speed: Mach 0.9
Guidance: Inertial and active radar
Warhead: 165 kg (363.7 lb) semi-armour-piercing

Manufacturer/Contractor

China Precision Machinery Import and Export Corporation (CPMIEC), Beijing, China.

SURFACE-TO-AIR MISSILES (SAM)

Thomson-CSF Crotale EDIR

There is a single Thomson-CSF Crotale EDIR octuple launcher mounted forward of the bridge, with the magazine immediately behind it. The system obtains search information from the Thomson-CSF Sea Tiger radar, while the director's own sensors are a two-axis stabilised Castor radar antenna, a missile guidance antenna, an infra-red localiser and a TV for low-level tracking. The localiser is designated *Ecartometrie Differentielle Infra-Rouge* (EDIR), while the VT-1 missile, which attains a speed of Mach 3-plus some 2.5 seconds after launch, can manoeuvre at up to 25 *g* in each axis. System reaction time from target acquisition to launch is a minimum of 4.5 seconds and an average of 6 seconds. Maximum range is about 10 km (11,000 yd). The system is capable of intercepting four separate targets simultaneously and there are two types of fuze: infra-red (V3N) and RF (V3S). The J-band monopulse radar has a peak power of 80 kW to give it a range in excess of 8.5 n miles (16 km) and has an accuracy of 0.3 mrad in tracking and 0.1 m in missile-to-target differential deviation measurement. The RIC has a deviation measurement accuracy of 1 mrad and is designed to gather the Crotale missile for the command link.

Specifications

Missile VT-1
Length: 2.34 m (7.68 ft)
Diameter: 16.5 cm (6.5 in)
Wing span: n/k
Weight: 73 kg (161 lb)
Speed: Mach 3.5
Warhead: 14 kg (30.9 lb)
Lethal radius: 8 m (26.25 ft)
Range: 10 km (11,000 yd)
Altitude: 4,000 m (13,120 ft)

Launcher-director
Weight: 6.5 t
Traverse: 360°

Sensor
Elevation: −25 to +85°
Radial velocity: 2 rad/s azimuth; 3 rad/s elevation

Mounting
Radial velocity: 1.5 rad/s azimuth; 1 rad/s elevation
Electrical power requirements: 440 V 60 Hz, 115 V 60 Hz, 115 V 400 Hz

Manufacturer/Contractor

Thomson-CSF, Division Systèmes Electroniques, Paris, France.

TORPEDOES

Whitehead B515 anti-submarine torpedo launching system

The B515 system consists of two triple 324 mm diameter torpedo tubes mounted on the open deck, with one

installation on each side of the ship abreast the mainmast. The tubes are manually loaded and trained but remotely operated from the combat information centre, although emergency local operation is possible.

Specifications
Length: 3.4 m (11.16 ft)
Height: 1.2 m (3.94 ft)
Width: 1.285 m (4.22 ft)
Weight: 1,050 kg (2,315 lb) (unloaded)

Manufacturer/Contractor
Whitehead, Division of Gilardini SpA.

Whitehead A244/S lightweight anti-submarine torpedo
The torpedo used by the 'Luhu' class destroyers is the Whitehead A244/S. The seeker in the A244/S is the Alenia CIACIO-S which is capable of active, passive or mixed modes for closing on to its target and can discriminate between decoys and real targets in the presence of heavy reverberations by specially emitted pulses and signal processing. It also discriminates between target noise and reverberations, as well as having a preset series of programmable search patterns and tactical manoeuvres (including re-attack procedures). The seeker has a large search volume covered by multiple preformed beams following a number of self-adaptive search patterns and is reported capable of target detection at −5 dB in good acoustic conditions. The computerised homing system also provides for presettable combinations of signal processing, spatial filtering and tactical torpedo manoeuvring. The software may be reprogrammed by the customer to meet new tactical conditions. Upon launching, the A244/S initially steers a straight course and, if the target is not detected, it then begins a search pattern which may be either a spiral between preselected depths or a helix pattern.

Specifications
Length: 2.7 m (8.86 ft)
Diameter: 324 mm (12.75 in)
Weight: 215 kg (474 lb)
Warhead: 34 kg (80 lb) shaped charge HBX-3 HE
Propulsion: Electric; silver-zinc batteries
Range: 3.5 n miles (6 km)
Speed: 30 kts
Guidance: Active/passive sonar, self-adaptive programmed patterns

Manufacturer/Contractor
Whitehead SpA, Salviano, Italy.

GUNS

Twin 100 mm/56
There is a single, dual-purpose (DP) turret forward, mounting two 100 mm (3.9 in)/56 guns. The gun housing is of a new Chinese design although it would appear that the guns are the same as the auto-loading type first seen in the Jianghu III frigates.

Specifications
Elevation: −5° to +85°
Rate of fire: 18 rds/min
Max range: 12 n miles (22 km)
Weight of shell: 15 kg (33.1 lb)
Muzzle velocity: 900 m/s (2,900 ft/s)
Rate of fire: 25 rds/min/barrel

Twin Type 76 37 mm/63
There are four twin 37 mm/63 mountings at the four corners of the superstructure: two immediately before the bridge and two at the after end of the hangar. This is a similar configuration to that found in the Luda III-type destroyers.

Specifications
Calibre: 62.8 mm
Elevation: 85°
Rate of fire: 180 rds/min
Max range: 4.6 n miles (8.5 km)
Weight of shell: 1.42 kg.

ANTI-SUBMARINE MORTARS

FQF-2500 12-tubed fixed launchers
There are two FQF-2500 rocket launchers mounted side by side in the bows. Each launcher has 12 tubes, with seven in an outer semicircle and five inside.

The FQF 2500 tubes are 250 mm in diameter and fire rockets weighing 70 kg (154.3 lb) with a 34 kg (74.9 lb) warhead. Range is approximately 0.8 n miles.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

BM-8610 ESM/ECM
The ESM/ECM system is designated BM-8610 and includes both radar warning and jamming elements.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher
There are two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications
Launcher
Dimensions: 160 × 43 × 86 cm
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)
Barrels: 6

Rounds
Mk 182: 1,209 × 130 mm; 22.7 kg
Super Chaffstar: 1,209 × 130 mm; 20.9 kg
Super Gemini: 451 × 130 mm; 5.5 kg
Super Hiram III: 1,220 × 130 mm; 13.6 kg
Super Hiram IV: 467 × 130 mm; 3.8 kg
Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturers/Contractors
Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

China 26-barrelled chaff launchers
There are two 26-barrelled chaff launchers. These are of Chinese design and manufacture, but their designation and specifications are not known.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Thomson-CSF TAVITAC
China ordered two TAVITAC systems which were delivered in 1990, but has no licence for production of the system. It is assumed that these are the systems installed in the first two 'Luhu' class destroyers. The Thomson-CSF Naval Tactical Data Systems TAVITAC (TAVITAC = *Traitement Automatique et Visualisation Tactique*) is a federated system linked by a local area network based on a Gina databus, with the associated sensors and weapons being connected directly to the LAN or via a network interface unit. The system uses two CIMSA Sintra 15M125 computers (32 bits; modular memory of 64-512 k words; operating speed of 1 Mips) and one CIMSA Sintra 15M05 (16 bit; 64 k memory), with programming using the LTR 2 language.

TAVITAC performs all the necessary tactical functions for the ship, and can carry up to 800 tracks, and can also provide a limited advisory capability in evaluating the tactical situation. In addition, using ruggedised disk storage, TAVITAC can provide a database management capability for other functions such as map display, ship resources and management.

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

COMMUNICATIONS AND DATALINKS

In addition to the normal communications to be found on a warship, there are two satellite (satcom) terminals either side of the foremast, the first to be seen on a Chinese warship.

RADARS

Hai Ying (Sea Eagle) air search
The Hai Ying radar antenna is the very large antenna mounted on the forward end of the hangar. This 3D air surveillance radar operates in the G-band.

Specifications
Azimuth coverage: 360°
Altitude coverage: 25,000 m (82,000 ft)
Range: 100 n miles (180 km)
Accuracy: ±100 m in range; ±0.8° in azimuth and elevation

Manufacturer/Contractor
Nanjing Marine Institute, Nanjing, PRC.

Thomson-CSF TRS 3004 Sea Tiger Mk 2 (DRBV 15C) surveillance radar
Sea Tiger is an E/F-band radar, whose main purposes are to detect and track missiles, including sea-skimmers in a very severe clutter and jamming environment. Its functions include: air surveillance; surface surveillance; anti-missile surveillance; and target designation for weapon systems (guns, missiles), with visibility in clutter being achieved through the use of circular polarisation, pulse compression, Doppler filtering, and an anti-clutter reception chain. There is a roll-stabilised antenna with integrated IFF. Sea Tiger Mk 2 (DRBV 15C) offers improvements in anti-jamming capabilities due to the development of a planar antenna with a very low sidelobe level.

Specifications
Operational performance
Detection range: 60 n miles on 2 m² (fluctuation) target with Pd <= 50 percent
Altitude detection: 15,240 m (50,000 ft)
Elevation pattern: Cosec² up to 50°
Sub-clutter visibility: >40 dB

Antenna
Gain: 30 dB
Polarisation: Circular/linear, switchable
Rotation speed: 15/30 rpm
Stabilisation: better than ±15°
Transmitter: Frequency agile, pulse compression
Receiver: Noise figure better than 5.5 dB

Manufacturer/Contractor
Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

ESR 1 surface search radar

ESR-1 is an I-band low-altitude air and surface search radar, which is claimed (in company brochures) to detect a 0.1 m² target at a height of 8 m (such as, an incoming sea-skimming missile) at ranges in excess of 6.5 n miles (12 km).

Specifications

Frequency: I-band
Beam: 2 × 10°
Gain: 33.5 dB
Scan rate: 22 rpm

Manufacturer/Contractor

China Shipbuilding & Trading Co, Beijing, China.

Racal Decca 1290 navigation radar

This I-band radar uses a 2.7 m (9 ft) antenna and has a peak power of 25 kW.

Manufacturer/Contractor

Racal Decca.

Type 347G fire-control radar

Type 347G is an I-band radar for fire-control of the YJ-1 anti-ship missiles and the 100 mm guns.

Two EFR 1 Rice Lamp fire-control radar

EFR-1 is the I-band fire-control radar for the 37 mm close in weapons systems.

Thomson-CSF CASTOR 2C (DRBC 33) fire-control radar

The Chinese Navy uses Castor 2C as the fire-control system for the Crotale SAM system. This is an I/J-band Doppler filtering tracking radar which is able to acquire and track targets in conditions of active jamming, chaff and heavy clutter. The system uses fully coherent transmission, frequency agility, analysis of received jamming signals within all the useful bandwidth, auto-adaptive Doppler filtering, and central management by computer to match the radar to the environmental conditions at all times.

Operationally, Castor 2C provides fully automatic acquisition to achieve very short reaction times, short burst operation (1.5 ms) with simultaneous frequency agility and Doppler processing, and pulse-to-pulse operation giving true frequency agility. Other facilities include TV tracking or combined TV/radar tracking; passive tracking of a jammer with range information sent from a tracking device linked to a surveillance radar; display of the angular error between the shells and the target; display of the angular tracking error on a jammer; and autonomous surveillance, either continuous or by sector.

Specifications

Frequency: I/J-band
Peak power: More than 30 kW
Range: 0.27-14.6 n miles (0.5-27 km)
Acquisition mode: Fully automatic

Manufacturer/Contractor

Thomson-CSF Systèmes Navals de Combat, Bagneux, France.

SONAR

Two sonars are fitted. One is a hull-mounted, active search and attack set operating at medium frequency. The other is a towed, variable depth sonar (VDS), also operating at medium frequencies.

AVIATION

AVIATION FACILITIES

Flight deck

The flight deck is at the stern and measures approximately 20 × 15.1 m (66 × 50 ft).

Hangar

The hangar has twin doors and accommodates both aircraft.

Harbin (HAMC) Z-9A Haitun

The 'Luhu' class carries two Harbin Z-9A Haitun twin-engined, multirole, naval helicopters. The Z-9A is a licence-built version of the AS 365 Dauphin, manufactured in China. Sensors include Thomson-CSF Agrion, HS-12 dipping sonar, and Crouzet MAD. Weapons can include a maximum of four PRC-designed anti-ship missiles, Whitehead A224 torpedoes, or locally manufactured 46 Mod 2 torpedoes.

Specifications

Main rotor:
  diameter: 11.94 m (39.17 ft)
  disc area: 111.97 m² (1,205.26 sq ft)
Fenestron:
  diameter: 1.10 m (3.61 ft)
  fenestron area: 0.95 m² (10.23 sq ft)
Length, overall, rotor turning: 13.68 m (44.88 ft)
Length, fuselage: 12.11 m (39.73 ft)
Height:
  overall: 3.99 m (13.09 ft)
  to top of rotor head: 3.52 m (11.55 ft)
Weights
  empty (standard aircraft): 2,262 kg (4,987 lb)
  max take-off: 4,250 kg (9,370 lb)
Radius of action:
  anti-shipping mission: four missiles, 135 n miles (250 km); two missiles, 150 n miles (278 km)
  search and rescue: 130 n miles (241 km)
Performance (at average mission weight of 4,000 kg; 8,818 lb)
Never-exceed speed (VNE): 160 kts (296 km/h)
Cruising speed at sea level: 148 kts (274 km/h)
Max rate of climb at sea level: 420 m (1,380 ft)/min
Hovering ceiling:
  in ground effect: 2,600 m (8,530 ft)
  out of ground effect: 1,860 m (6,102 ft)
Power plant: 2 Turbomeca Arriel 1M1 turboshafts, each giving 558 kW (749 shp) for take-off and 487 kW (653 shp) continuously
Accommodation: 2 (pilot, co-pilot). The cabin can hold up to 10 passengers

PROPULSION

Specifications

System: Combined diesel or gas (CODOG)
Main machinery: 2 General Electric LM-2500 gas turbines (see Programme (below)); 41 MW (55,000 hp) sustained. 2 MTU 12V 1163 TB83 diesels; 6.5 MW (8,840 hp(m)) sustained
Shafts: 2
Propellers: 2 cp

FURTHER INFORMATION

PROGRAMME

The first of this new class was ordered in 1985 but was then delayed due to priority being given to export orders for Thailand. It was originally planned to fit US weapons, sensors and propulsion, but, except for a few items, this plan was negated by the 1989 embargo. The type is now in series production, although the third of class has suffered further delays because of problems obtaining replacements for the LM-2500 gas turbines which were due to be fitted and it is reported that this and subsequent ships may be powered instead by gas turbines obtained from the Ukraine.

DESIGN

These are elegant ships, representing a major advance on previous Chinese destroyer and frigate designs. They have a well-balanced armament and a wide range of sensors and, in addition to much new Chinese equipment, they also incorporate a considerable amount of foreign equipment obtained from Western companies.

Among the noteworthy features are the Crotale SAM launcher, improved radars and fire-control systems, and modern 37 mm and 100 mm guns. The eight CJ-1 launchers give the ships a substantial anti-ship capability and it is possible that the missile is an extended range version of the C-801.

Haribing, *first of the class was commissioned in 1994, but the remaining ships have been delayed as priority has been given in the shipyards to meeting the Thai frigate orders. This design represents a significant advance in Chinese warship design* (H & L van Ginderen Collection)

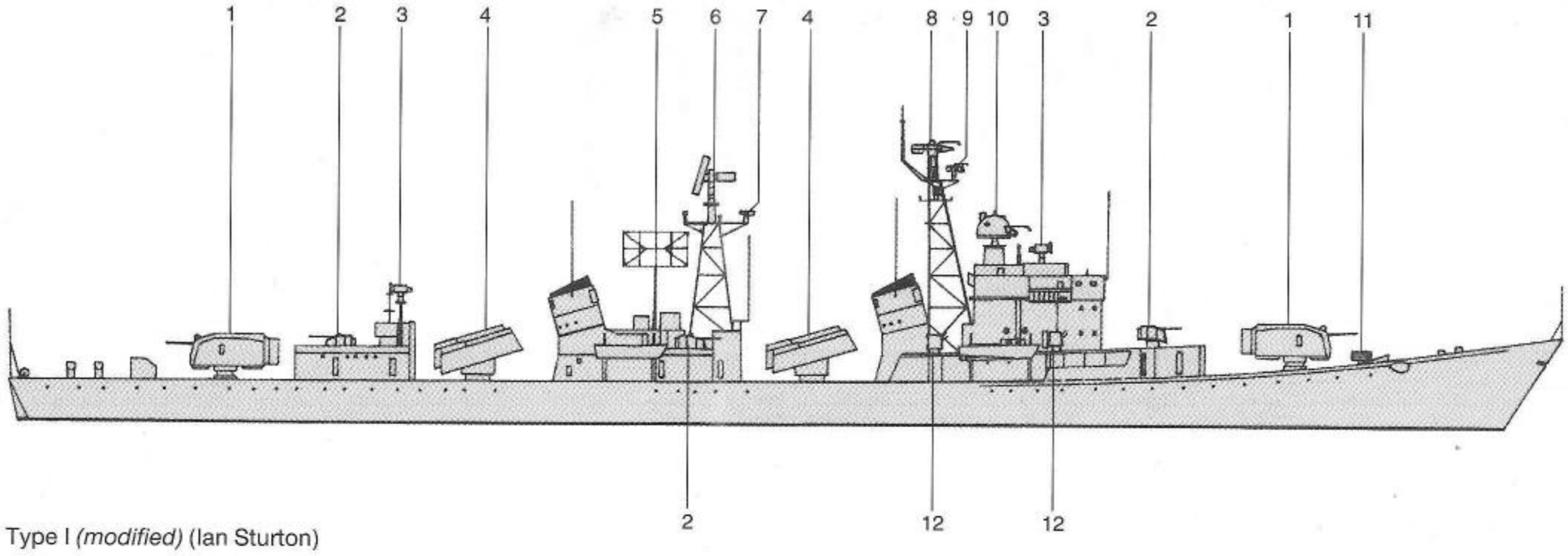
There is an interesting difference between the first two ships in their engine uptakes. In *Haribing* the uptake incorporates a large rear 'lip', similar to those found in Italian 'Maestrale' class frigates, whereas in *Qingdao* the stack is capped by large cylindrical IR suppressors, similar to those found in US 'Spruance' and 'Arleigh Burke' class destroyers.

The fully enclosed main mast appears far too substantial to support the antennas currently fitted and it could well be that some new form of large and heavy sensor is to be fitted in due course.

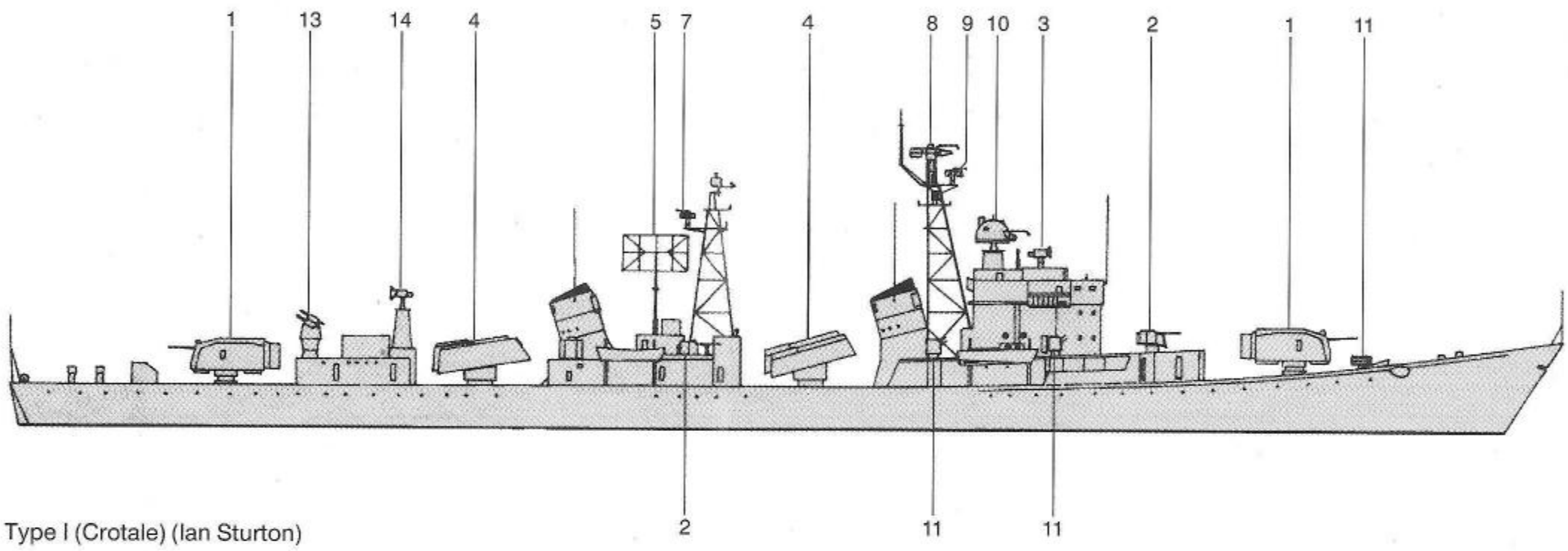
OPERATIONAL

The first of class started trials in late 1992, followed by the second of class in 1995. It is anticipated that at least six of these ships will be constructed.

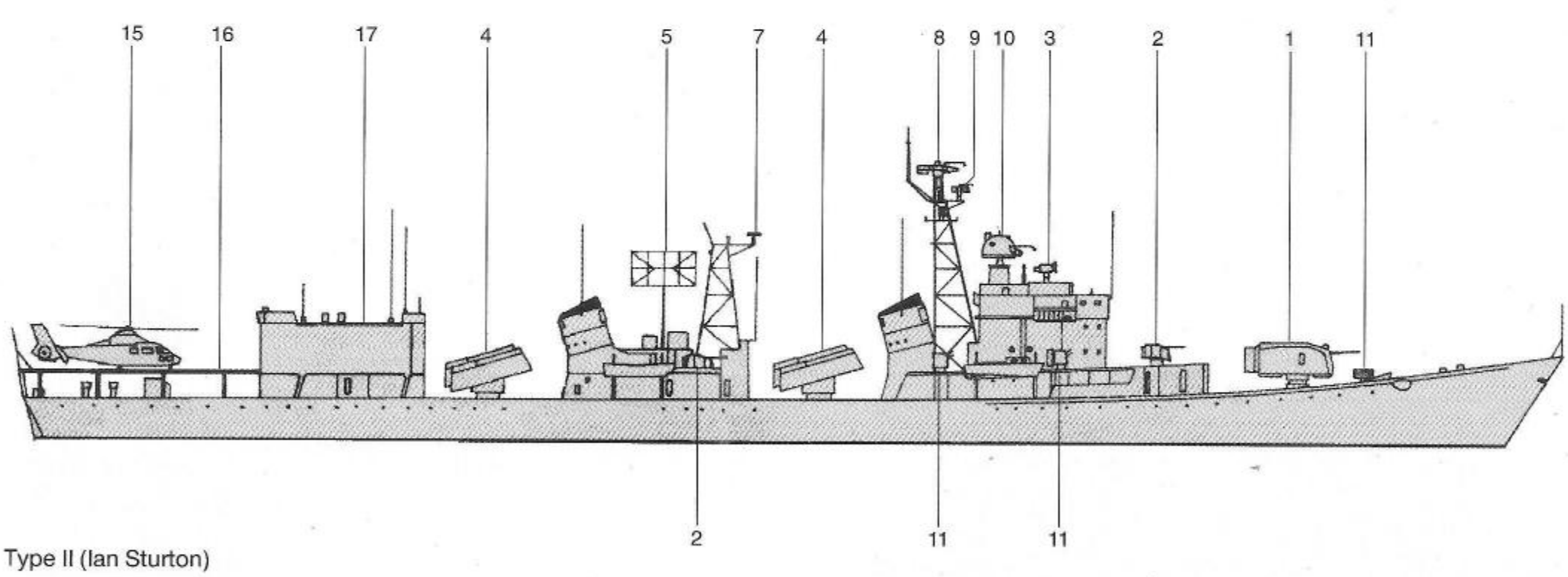
LUDA



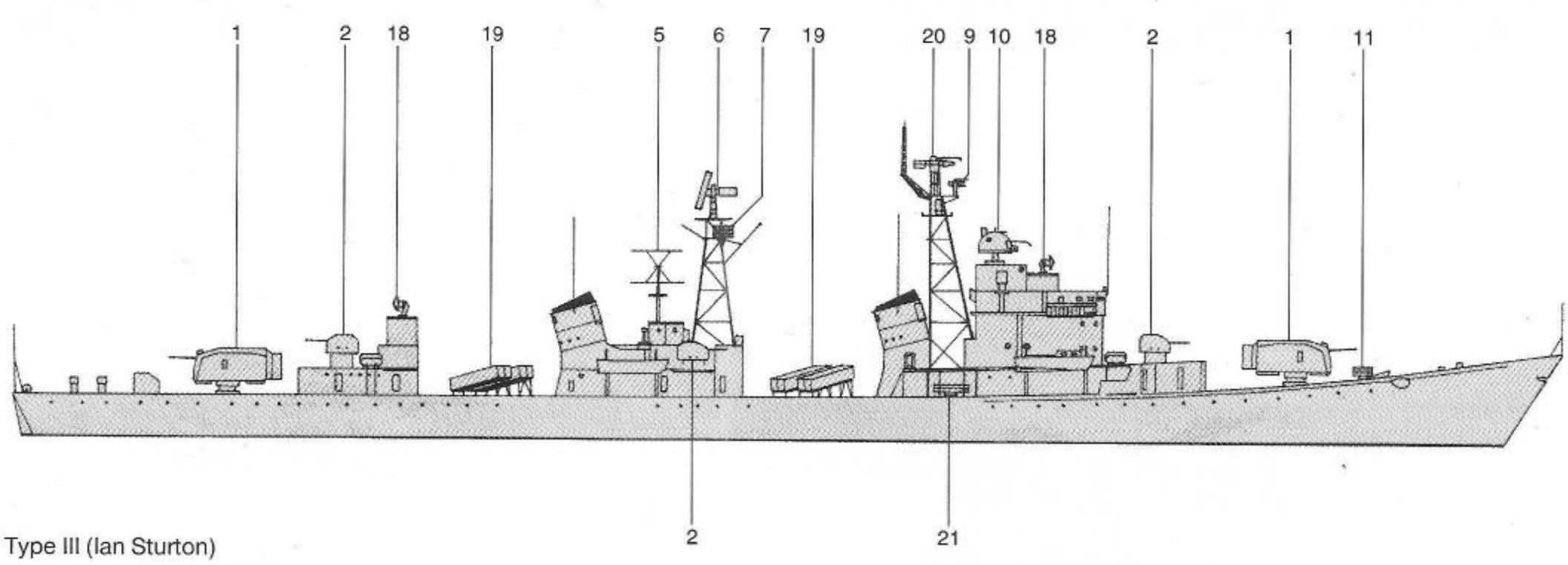
Type I *(modified)* (Ian Sturton)



Type I (Crotale) (Ian Sturton)



Type II (Ian Sturton)



Type III (Ian Sturton)

1 *130 mm (5.1 in)/58 twin gun mounting* **2** *37 mm/54 twin mounting* **3** *Rice Lamp or Type 347* **4** *HY-2 SSM triple launcher* **5** *Knife Rest/Cross Slot/Bean Sticks/ Pea Sticks long-range air search radar* **6** *Rice Screen 3D radar (air search)* **7** *Navigation radar* **8** *Eye Shield/Sea Tiger radar (surface search)* **9** *Radar* **10** *Wasp Head/Sun Visor B fire control* **11** *FQF-2500 12-tube ASW mortar (two)* **12** *25 mm/60 twin cannon* **13** *Thomson-CSF Crotale eight missile launcher* **14** *Thomson-CSF Castor II fire control (Crotale)* **15** *Harbin Zhi-9A (Dauphin) helicopter (two)* **16** *Flight Deck* **17** *Hangar* **18** *Type 347G fire control* **19** *YJ-1 (C-801) two twin launchers* **20** *ESR-1 radar (surface search)* **21** *B515 324 mm triple torpedo launcher (two)*

GENERAL SPECIFICATIONS

Country of origin: People's Republic of China
Operator: People's Republic of China
Type: Type 051

Class: LUDA I/II/III

Luda I
Built: 15
Active: 13

Luda II
Converted from Luda I: 1
Active: 1

Luda III
Built: 1
Active: 1
Building: 1 (?)

Displacement:
standard: 3,250 t
full load: Luda I/II, 3,670 t; Luda III, 3,730 t

Dimensions
Length: 132 m (433.1 ft)
Beam: 12.8 m (42 ft)
Draught: Luda I/II, 4.6 m (15.1 ft); Luda III, 4.7 m (15.3 ft)

Speed: 32 kts
Range: 2,970 n miles at 18 kts

Complement: 280 (45 officers)

SHIPS

TYPE I

XIAN (106)
Builder Luda Shipyard, China
Completed 1972

YINCHUAN (107)
Builder Luda Shipyard, China
Completed 1972

XINING (108)
Builder Luda Shipyard, China
Completed 1973

KAIFENG (109)
Builder Luda Shipyard, China
Completed 1974

DALIAN (110)
Builder Luda Shipyard, China
Completed —

NANJING (131)
Builder Shanghai Shipyard, China
Completed 1974

HEFEI (132)
Builder Shanghai Shipyard, China
Completed 1975

CHONGQING (133)
Builder Shanghai Shipyard, China
Completed —

ZUNYI (134)
Builder Shanghai Shipyard, China
Completed —

CHANGSHA (161)
Builder Guangzao Shipyard, China
Completed 1975

NANNING (162)
Builder Guangzao Shipyard, China
Completed 1980

NANCHANG (163)
Builder Guangzao Shipyard, China
Completed 1980

GUILIN (164)
Builder Guangzao Shipyard, China
Completed Apr 1987

ZHANJIANG (165)
Builder Guangzao Shipyard, China
Completed Jun 1992

TYPE II

JINAN (105)
Builder Luda Shipyard, China
Completed 1972
Reconstruction completed 1987 (Luda II)

TYPE III

ZHUHAI (166)
Builder Dalian Shipyard
Laid down 1988
Launched 1991
Commissioned 1993

Zhuhai *on a foreign deployment, wearing its 'overseas' pennant number 168 (it wears 166 in home waters)* (Jane's/H M Steele)

A Luda I destroyer of the PLAN (a censor has deleted the pennant number). The original version of this design, the Luda I has two twin 130 mm gun mountings, two triple-tube HY-2 guided missile launchers, and two twin 37 mm mounts. It is also equipped with sonars, a variety of radar sets and an action information system (China Shipbuilding (CSSC))

WEAPONS SYSTEMS

Summary

Weapons systems		Luda I (less *Kaifeng*)	*Kaifeng*	Luda II	Luda III
Missiles	HY-2 SSM	6 (2 × 3)	6 (2 × 3)	6 (2 × 3)	–
	YJ-1 SSM	–	–	–	8
	Crotale	–	8 (1 × 8)	–	–
	CY-1 ASW	–	–	–	4
Guns	130 mm	4 (2 × 2)	4 (2 × 2)	2 (1 × 2)	4 (2 × 2)
	57 mm or 37 mm	8 (4 × 2)	–	–	–
	57 mm	–	6 (3 × 2)	6 (3 × 2)	
	37 mm	–	–	–	8 (4 × 2)
	25 mm	8 (4 × 2)	8 (4 × 2)	8 (4 × 2)	
Torpedo tubes	533 mm tubes	6	6	6	6
ASW mortars	FQF 2500	2	2	2	2
Depth charges	Racks	2 or 4	–	–	–
Helicopters	Harbin Z-9A	–	–	2	–

SURFACE-TO-SURFACE MISSILES (SSM)

HY-2 (NATO = CSSC-3 'SEERSUCKER') medium-range anti-ship missile

Luda I and II destroyers are armed with six HY-2 (C-201) anti-ship missiles mounted in two triple launchers. These launchers are located abaft each of the two stacks and are trained to the beam to fire, but are fixed in elevation.

The HY-2 missile was developed from the HY-1, which, in its turn, was developed from the Soviet SS-N-2 Styx.

The firing sequence is operated from a dedicated console with its own analogue computer and ripple launches are possible. Once the target is confirmed as hostile the operator manually sets a range gate around it and feeds in location, speed and ballistic data. The computer then feeds the firing solution to the missile autopilot. After launch the HY-2 climbs to its cruise altitude of 30 m (100 ft), which it maintains until entering the terminal phase when it descends to about 8 m (26 ft).

In the deep sea vessels the Type 254 radar is used for missile fire control and is supplemented by a dedicated surface search radar. The HY-2 offers a selection of seekers in addition to the I-band radar: an infra-red seeker (HY-2A) and a monopulse active radar seeker (HY-2G).

Specifications

Length: 7.36 m (24.1 ft)
Diameter: 76 cm (30 in)
Wing span: 2.4 m (7.87 ft)
Launch weight: 2,500 kg (5,511 lb)
Speed: Mach 0.9
Warhead: 454 kg (1,000 lb) hollow charge
Range: 51 n miles (95 km)
Guidance: Autopilot, active radar, or IR seeker

Manufacturer/Contractor

China Precision Machinery Import and Export Corporation (CPMIEC), Beijing, China.

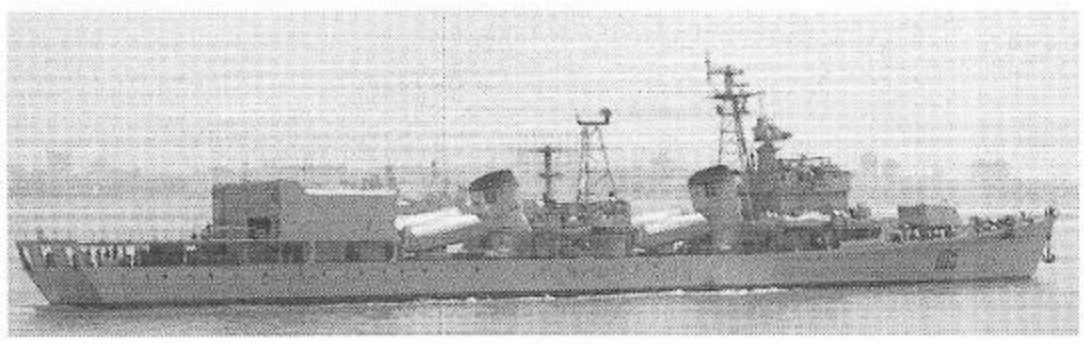
Ying Ji (Eagle Strike) YJ-1 (C-801) missiles

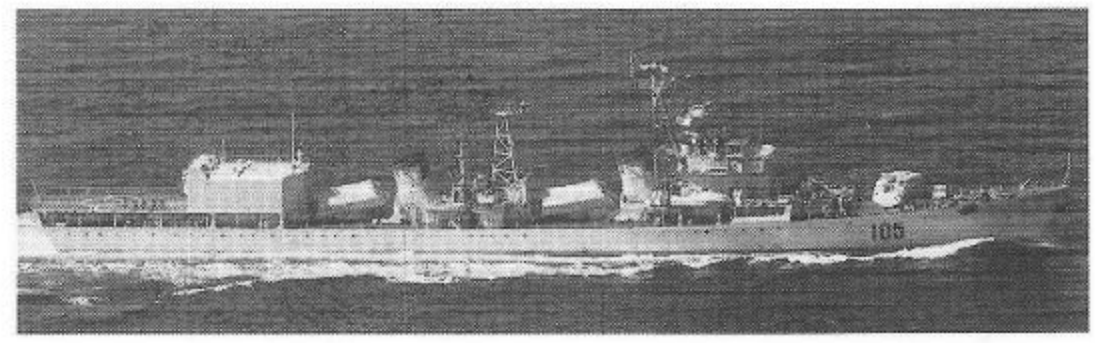
The Luda III has eight launchers for Ying Ji YJ-1 (C-801) SSMs. The forward group of four launchers is located between the forward stack and the mainmast facing to port, while the second group face to starboard, abaft the after stack. The YJ-1 is rocket-propelled with a rocket booster, and on launch it climbs to about 50 m (160 ft) then descends to 20 to 30 m (66 to 100 ft) until its radar seeker has acquired the target. It then descends to 5 to 7 m (16 to 23 ft) using the nose-mounted, monopulse (probably J-band) radar seeker for the terminal approach phase.

Specifications

Length: 5.81 m (19.06 ft)
Diameter: 36 cm (14.17 in)
Wing span: 1.18 m (3.87 ft)
Propulsion: Rocket motor
Weight: 815 kg (1,797 lb)

Zhuhai *is the sole Luda III destroyer so far completed, although more may be under construction. The principal difference from previous versions is the replacement of the large, bulky triple launchers for the C-201 missiles by the small, neat launchers for C-801 missiles. Note also how the two FQF-2500 ASW mortars are sited, with one above and behind the other. Note also that the number of radars, ESM and ECM devices on Chinese ships is increasing rapidly* (H & L van Ginderen Collection)





Jinan, *the only Luda II, has had the after 130 mm mount replaced by a flight deck and hangar for two Haitun (licence-produced Dauphin) helicopters. It has, however, retained the two triple HY-2 missile launchers*

Range: 4.5-23 n miles (8-42 km)
Speed: Mach 0.9
Guidance: Inertial and active radar
Warhead: 165 kg (363.7 lb) semi-armour-piercing

Manufacturer/Contractor
China Precision Machinery Import and Export Corporation (CPMIEC), Beijing, China.

SURFACE-TO-AIR MISSILES (SAM)

Thomson-CSF Crotale EDIR octuple launcher
In *Kaifeng* only, there is a single octuple Thomson-CSF Crotale EDIR launcher mounted on the roof of the after deckhouse with the magazine immediately forward of it, thus displacing one of the 37 mm mountings and a Rice Lamp fire-control radar. The system comprises a combined director and missile-launching mounting, a fire-control room with supporting electronics and a supervising console in the combat information centre. There is also a missile handling and storage system. The system obtains search information from the Thomson-CSF Sea Tiger radar, while the director's own sensors are a two-axis stabilised Castor radar antenna, a missile guidance antenna, an infra-red localiser and a TV for low-level tracking. The localiser is designated *Ecartometrie Differentielle Infra-Rouge* (EDIR), while the VT-1 missile, which attains a speed of Mach 3-plus some 2.5 seconds after launch, can manoeuvre at up to 25 *g* in each axis. System reaction time from target acquisition to launch is a minimum of 4.5 seconds and an average of 6 seconds. Maximum range is about 10 km. The system is capable of intercepting four separate targets simultaneously and there are two types of fuze: infra-red (V3N) and RF (V3S). The J-band monopulse radar has a peak power of 80 kW to give it a range in excess of 8.5 n miles (16 km) and has an accuracy of 0.3 mrad in tracking and 0.1 m in missile-to-target differential deviation measurement. The RIC has a deviation measurement accuracy of 1 mrad and is designed to gather the Crotale missile for the command link.

Specifications
Missile VT-1
Length: 2.34 m (7.68 ft)
Diameter: 16.5 cm (6.5 in)
Wing span: n/k
Weight: 73 kg (161 lb)
Speed: Mach 3.5
Warhead: 14 kg (30.9 lb)
Lethal radius: 8 m (26.25 ft)
Range: 10 km (11,000 yd)
Altitude: 4,000 m (13,120 ft)

Launcher-director:
Weight: 6.5 t
Traverse: 360°

Sensor
Elevation: −25 to +85°
Radial velocity: 2 rad/s azimuth; 3 rad/s elevation

Mounting
Radial velocity: 1.5 rad/s azimuth; 1 rad/s elevation
Electrical power requirements: 440 V 60 Hz, 115 V 60 Hz, 115 V 400 Hz

Manufacturer/Contractor
Thomson-CSF, Division Systémes Electroniques, Paris, France.

TORPEDOES

Whitehead B515 anti-submarine torpedo launching system
Some of the Type I ships have six (two triple) torpedo launchers. The B515 system consists of two triple 324 mm diameter torpedo tubes mounted on the open deck, with one installation on each side of the ship abreast the mainmast. The tubes are manually loaded and trained but remotely operated from the combat information centre, although emergency local operation is possible.

Specifications
Length: 3.4 m (11.15 ft)
Height: 1.2 m (3.94 ft)
Width: 1.285 m (4.22 ft)
Weight: 1,050 kg (2,315 lb) (unloaded)

Manufacturer/Contractor
Whitehead, Division of Gilardini SpA.

Whitehead A244/S lightweight anti-submarine torpedo
The torpedo used by the 'Luda' class destroyers is the Whitehead A244/S. The seeker in the A244/S is the Alenia CIACIO-S which is capable of active, passive or mixed modes for closing on to its target and can discriminate between decoys and real targets in the presence of heavy reverberations by specially emitted pulses and signal processing. It also discriminates between target noise and reverberations, as well as having a preset series of programmable search patterns and tactical manoeuvres (including re-attack procedures). The seeker has a large search volume covered by multiple preformed beams following a number of self-adaptive search patterns and is reported capable of target detection at −5 dB in good acoustic conditions. The computerised homing system also provides for presettable combinations of signal processing, spatial filtering and tactical torpedo manoeuvring. The software may be reprogrammed by the customer to meet new tactical conditions. Upon launching, the A244/S initially steers a straight course and, if the target is not detected, it then begins a search pattern which may be either a spiral between preselected depths or a helix pattern.

Specifications
Length: 2.7 m (8.86 ft)
Diameter: 324 mm (12.75 in)
Weight: 215 kg (474 lb)
Warhead: 34 kg (80 lb) shaped charge HBX-3 HE
Propulsion: Electric; silver-zinc batteries
Range: 3.5 n miles (6 km)
Speed: 30 kts
Guidance: Active/passive sonar, self-adaptive programmed patterns

Manufacturer/Contractor
Whitehead SpA, Salviano, Italy.

GUNS

130 mm (5.1 in) twin L/58 (56SM) mounting
The Type I and Type II ships are armed with two twin 76 mm mountings, one forward, the other aft; the sole Type III only has the forward mounting, the after turret having been removed to make way for the hangar. The 56SM 130 mm L/58 calibre weapon is of Russian origin and was also produced in some numbers in China. The gun itself is similar in design to the Russian Army's M-46 field gun, but without the latter's muzzle brake. The air-cooled barrel is 7.6 m long and is of monobloc construction with horizontal sliding wedge breech block. The recoil cylinder is underneath the gun and, as is common with Soviet medium calibre gun mountings of this period, the elevating mass is set well back from the front of the turret. The tri-stabilised steel turret weighs 40 t and is on a cylindrical steel base approximately 1 m high. It is manned with the gun captain at the front of the turret to the left of the elevating mass. Chinese mountings have either their own ranging radar or an electro-optical system.

Specifications
(L/58)
Length of barrel: 58 calibres
Muzzle velocity: 930 m/s
Traverse: 360°
Elevation: −5 to +89°
Ammunition: 27 kg
Rate of fire: 20 rds/min
Range:
anti-surface: 15 n miles (28 km)
AA: 13,000 m (42,650 ft)

57 mm L/77 (ZIF-31B) gun in Type 76 mounting
These ships have either 57 mm or 37 mm mountings; see Summary above. The air-cooled 57 mm ZIF-31B is a conventional weapon using a vertical wedge breech block with the casing containing part of the loading system while the elevation gear is below it. Rounds are fed into the loading system at the top of the gun with the clips being removed as the individual rounds are fed onto the loading tray. The round is automatically fed into the breech whose block is locked as it moves forward from recoil. Subsequently the breech opens and extractor arms remove the spent round and eject it.

Specifications
(ZIF-31B)
Length of barrel: 77 calibres
Muzzle velocity: 1,000 m/s
Traverse: 360° at 25°/s
Elevation: −10 to +85° at 40°/s
Crew: 5
Range: 4.52 n miles (8.4 km) surface/surface; 4,500 m (max, AA)
Rate of fire: 120 rds/min/barrel
Ammunition: 2.81 kg

Manufacturer/Contractor
Norinco, Beijing, China.

37 mm (W-11-M) Mountings
The 37 mm gun is a 62.8 calibre weapon with a flash suppressor. In the twin mounting the barrels are enclosed in separate water jackets with exposed spring recuperators and a hydraulic recoil buffer underneath the barrel. The loading mechanism consists of guides for ammunition, which is in five-round clips, the clips being automatically removed on the loading tray. The first round is loaded manually into the breech. The breech block rises and the gun fires when the firing pin strikes the cartridge percussion cap. Upon recoil the breech block opens and extractor arms propel the case along the loading tray and down an ejection chute. The recoil forces activate the loading mechanism and allow following rounds to be rammed automatically into the breech.

Specifications
(W-11-M)
Calibre: 37 mm
Length of barrel: 62.8 calibres
Muzzle velocity: 886 m/s
Traverse: 360° at 17°/s
Elevation: −10 to +85° at 13°/s
Rate of fire (per barrel): 80 rds/min
Ammunition:
(projectile): 0.732 kg
(complete rd): 1.42 kg
Range:
anti-surface: 2.2 n miles (4 km)
anti-air: 3,000 m
Crew: 3

Ammunition (HE-T)
Projectile Weight: 708 g
Explosive charge: 36 g (RDX/aluminium)
Muzzle velocity: 886 m/s

8 USSR 25 mm/60 (4 twin); 85° elevation; 270 rds/min to 1.6 n miles (3 km) anti-aircraft; weight of shell 0.34 kg.

23 mm/63 calibre Type 61 twin cannon
All Type I and Type II ships have four 23 mm/63 calibre Type 61 twin cannon mounts: two are abreast the bridge and two either side of the foremast (none in Luda III). The 2-M-3 consists of two guns one above the other in separate cradles and mounted on their sides so that they can be fed from their sides, which in the case of the Type 61 is the right-hand side. The 1.5 m long air-cooled barrels have a flash suppressor and an exposed spring recuperator wrapped around the barrel near the breech, with a hydraulic recoil buffer on the underside. The weapon has a vertical wedge breech block and the breech casing contains both the breech mechanism and part of the loading mechanism.

The ammunition is either in five-round clips or 65-round belts whose boxes are attached to the trunnions. The first round is loaded manually into the breech, the breech block rises and the gun fires when the firing pin strikes the cartridge percussion cap. Upon recoil the breech block opens and extractor arms propel the spent case along the loading tray and down a chute to one side of the gun. The recoil forces activate the

loading mechanism and allow succeeding rounds to be rammed into the breech automatically. The mounting may be either hydraulically or manually operated, and in the latter case needs a seven-man crew: two on-mount operators and five loader-carriers.

Specifications

(2-M-3)
Calibre: 25 mm
Length of barrel: 60 calibres
Traverse: 360° at 25°/s
Elevation: −10 to +85°at 15°/s
Rate of fire (per barrel): 450 rds/min
Projectile: 0.28 kg HEI-T
Range:
anti-surface: 1.5 n miles (2.75 km)
AA: 2,800 m

ANTI-SUBMARINE MORTARS

FQF-2500 12-tubed fixed launchers

There are two FQF-2500 rocket launchers mounted side by side in the bows. Each launcher has 12 tubes, with seven in an outer semicircle and five inside.

The FQF-2500 tubes are 250 mm (9.84 in) in diameter and fire rockets weighing 70 kg (154 lb) with a 34 kg (75 lb) warhead. Range is approximately 0.8 n miles. 120 rockets are carried.

DEPTH CHARGES

Luda I only has 2 or 4 BMB projectors, plus 2 or 4 racks.

MINES

Luda I can only carry and lay 38 mines.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES ESM

RW-23-1

These ships carry RW-23-1 (NATO = Jug Pair) radar warning receiver, covering the frequencies 2-18 GHz in four bands.

Manufacturer/Contractor

China National Electronics Import and Export Co, Beijing, China.

ELECTRONIC COUNTERMEASURES

Two Chinese-pattern chaff launchers are fitted in some of the class.

COMMAND AND CONTROL SYSTEMS

Thomson-CSF TAVITAC

Some Luda Is are believed to have TAVITAC systems and the system is fitted in Luda II and Luda III. The Thomson-CSF Naval Tactical Data Systems TAVITAC (TAVITAC = *Traitement Automatique et Visualisation Tactique*) is a federated system linked by a local area network based on a Gina databus, with the associated sensors and weapons being connected directly to the LAN or via a network interface unit. The system uses two CIMSA Sintra 15M125 computers (32-bits; modular memory of 64 to 512 k words; operating speed of 1 Mips) and one CIMSA Sintra 15M05 (16-bit; 64 k memory), with programming using the LTR 2 language.

TAVITAC performs all the necessary tactical functions for the ship, and can carry up to 800 tracks, and can also provide a limited advisory capability in evaluating the tactical situation. In addition, using ruggedised disk storage, TAVITAC can provide a database management capability for other functions such as map display, ship resources and management.

Manufacturer/Contractor

Thomson-CSF, Systèmes Navals de Combat, Bagneux, France.

RADARS

Role	Radar	Band	Luda I/II	Luda III
Air search	Knife Rest or Cross Slot or Bean Sticks or Pea Sticks	A E/F	One in all	No
	Rice Screen 3D	G	In some	Yes
Surface search	Eye Shield or Thomson-CSF Sea Tiger	E E/F	One in all	No
	Square Tie	I	In some	No
	ESR-1	I	No	Yes
Navigation	Fin Curve	I	In some	No
	Racal Decca 1290	I	In some	Yes
Fire control	Wasp Head	G/H	In some	No
Fire control	Type 343 (Sun Visor B)	G/H	In some	Yes
Fire control (guns)	2 Rice Lamp (series 2) I band	I	In some	No
	2 Type 347G	I	In some	Yes
Fire control (Crotale)	Thomson-CSF Castor II	I/J	*Kaifeng* only	

COMMUNICATIONS AND DATALINKS

IFF: High Pole.

SONAR

Pegas 2M and Tamir 2

Luda I and Luda II are fitted with either Pegas 2M or Tamir 2 sonars; both are hull-mounted, active search and attack, high-frequency sonars, using old technology. Tamir is a Soviet Navy copy of a British Second World War sonar and entered service in the late 1940s, while Pegas was its successor and entered service with the Soviet Navy in the 1950s.

Luda III has a hull-mounted active search and attack sonar, and a transom-mounted VDS. The type of either has yet to be established.

AVIATION

AVIATION FACILITIES

The only ship with aviation facilities is *Jinan*, the sole Luda II. This ship has a large flight deck and a double hangar, which accommodates two Harbin Z-9A Haitun helicopters.

Specifications

Flight deck: 21 × 12.8 m (68 × 42 ft)
Hangar: 10 × 12.8 m (32 × 42 ft)

HELICOPTERS

Harbin (HAMC) Z-9A Haitun

The 'Luda II' class carries two Harbin Z-9A Haitun twin-engined, multirole, naval helicopters. The Z-9A is a licence-built version of the AS 365 Dauphin, manufactured in China. Sensors include Thomson-CSF Agrion, HS-12 dipping sonar, and Crouzet MAD. Weapons can include a maximum of four PRC-designed anti-ship missiles, Whitehead A244 torpedoes, or locally manufactured 46 Mod 2 torpedoes.

Specifications

Main rotor:
diameter: 11.94 m (39.17 ft)
disc area: 111.97 m² (1,205.26 sq ft)
Fenestron:
diameter: 1.10 m (3.61 ft)
fenestron area: 0.95 m² (10.23 sq ft)
Length, overall, rotor turning: 13.68 m (44.88 ft)
Length, fuselage: 12.11 m (39.73 ft)
Height:
overall: 3.99 m (13.09 ft)
to top of rotor head: 3.52 m (11.55 ft)
Weights:
empty (standard aircraft): 2,262 kg (4,987 lb)
max take-off: 4,250 kg (9,370 lb)
Anti-shipping mission:
4 missiles: 135 n miles (250 km)
2 missiles: 150 n miles (278 km)
search and rescue: 130 n miles (241 km)
Performance (at average mission weight of 4,000 kg; 8,818 lb)
Never-exceed speed (VNE): 160 kts (296 km/h)
Cruising speed at sea level: 148 kts (274 km/h)
Max rate of climb at sea level: 420 m (1,380 ft)/min

Hovering ceiling:
in ground effect: 2,600 m (8,530 ft)
out of ground effect: 1,860 m (6,102 ft)
Power plant: 2 Turbomeca Arriel 1M1 turboshafts, each giving 558 kW (749 shp) for take-off and 487 kW (653 shp) continuously
Accommodation: 2 (pilot, co-pilot). The cabin can hold up to 10 passengers

The aircraft operated from the Luda II is the Zhi-9A Haitun (CSSC)

PROPULSION

Specifications

System: steam turbines
Main machinery: 2 boilers; 2 turbines; 53 MW (72,000 hp (m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

These were the first Chinese-designed destroyers of such an advanced capability to be built, with the first of class — *Jinan* (105) — being completed in 1971. The programme was much retarded after 1971 by drastic cuts in the defence budget. The production programme consisted of three series: 105-110 built at Luda; 131-134 built at Shanghai; and 160-165 built at Guangzhou.

Three ships differ substantially from the others. One is *Kaifeng* (109) which has the French Crotale SAM system in place of the after 37 mm gun mounting, but has not been given a separate subtype number. *Jinan* (105), the first of class, was refitted and rebuilt, reappearing in 1987 with a large flight deck and hangar, and has been reclassified as a Luda II.

The third ship is *Zhuhai* (168) which was first commissioned in 1993. This ship has YJ-1 SSMs in place of HY-2s, the same new missiles as are now appearing in the 'Luhu' class. In addition, this is the first ship to carry CY-1 ASW missiles. A second of class is reported to be building.

Luda I at sea showing its Type 343 (Sun Visor B) fire director (on the bridge roof); Eye Shield surface search radar (foremasthead); Rice Screen 3D air search radar (mainmast); and Bean Sticks long-range air search radar (aft) (CSSC)

DESIGN

The overall design has certain similarities to the Soviet 'Kotlin' class, although it seems possible that it was based on the 'one-off' Neustrashimy which was commissioned in 1955 and scrapped in 1974. In the Chinese design, however, the superstructure has been rearranged and the torpedo tubes deleted to accommodate Chinese missile systems.

The sensor fit is of relatively poor quality and capability compared to contemporary Soviet and Western destroyers, and command and control arrangements are limited, but these ships undoubtedly have done a great deal to establish Chinese warship design and construction capabilities. They have also enabled the PLA-Navy to undertake 'blue water' deployments.

Electronics fits vary in later ships and the Thomson-CSF Thomsea combat data system (including Vega FCS) has been installed in at least two of the class. The Crotale SAM system is installed in *Kaifeng* (109) in X gun position. In some ships the secondary gun armament consists of 57 mm guns while others have 37 mm instead.

MODERNISATION

The first of class, *Jinan* (105) was taken in hand for a major refit in the mid-1980s and returned to service in 1987. It has been redesignated Luda II in view of the major changes, which include the removal of the after deckhouse and 130 mm gun mounting, and their replacement by a large flight deck and hangar to accommodate two Harbin Haitun helicopters. There are also reports that the flight deck includes an Alcatel 'Safecopter' landing aid.

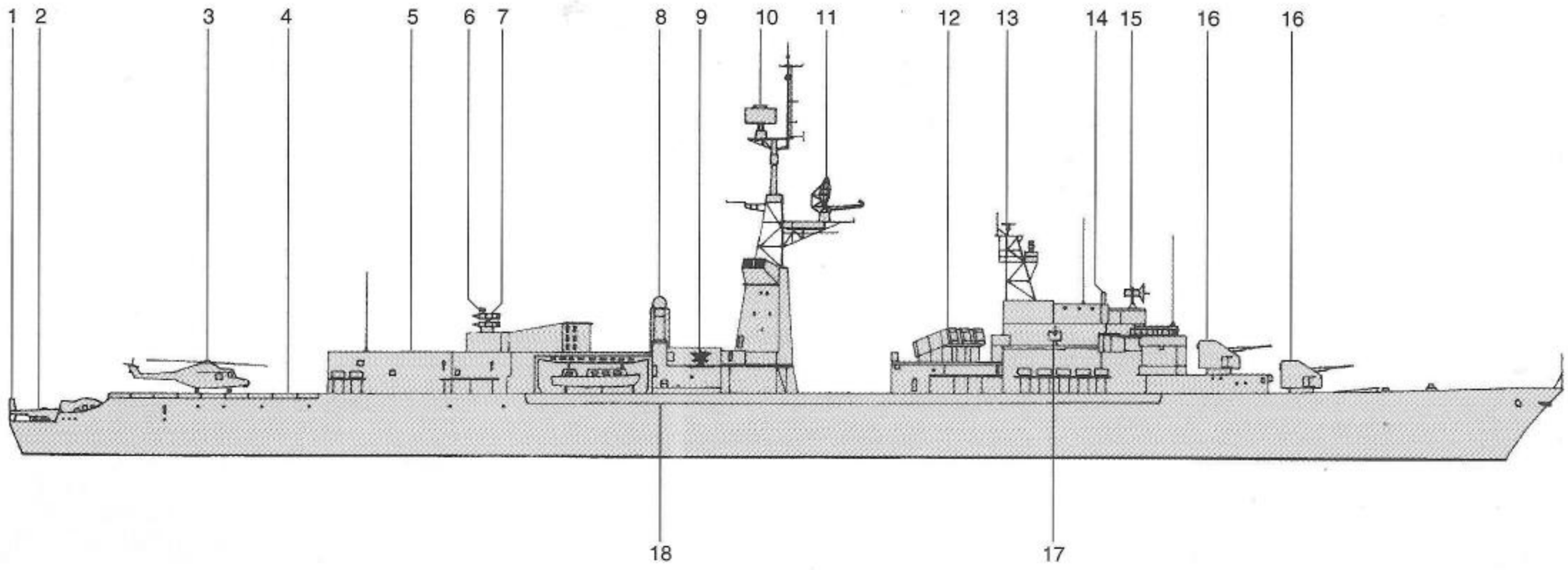
OPERATIONAL

These ships have a full 'blue water' capability and are capable of foreign deployments. They are fitted for underway replenishment, which is practised regularly.

Normal deployment is for the 106 series to be split between the North and East Sea Fleets; 131 series in the East Sea Fleet; and the 161 series in the South Sea Fleet.

160 was damaged by an explosion in 1978 and was scrapped.

TOURVILLE



De Grasse (Ian Sturton)
1 *Racal-Decca Type 1226 radar (helicopter control)* **2** *DUBV-43C VDS* **3** *Westland Lynx WG.13 helicopter (two)* **4** *Flight deck* **5** *Hangar* **6** *Crotale radar* **7** *Crotale missile launcher* **8** *Syracuse 1/2 Satcom* **9** *CSEE Syllex chaff/decoy launcher* **10** *Thomson-CSF DRBV-51B radar (air/surface search)* **11** *DRBV 26 air search radar* **12** *Aerospatiale MM 38 Exocet launchers (six total)* **13** *Racal-Decca Type 1226 radar (navigation)* **14** *INMARSAT* **15** *Thomson-CSF DRBC-320 fire-control radar* **16** *Modèle 68 100 mm (3.9 in)/55 single automatic gun mountings* **17** *Oerlikon 20 mm cannon (two)* **18** *533 mm (21 in) torpedo launcher (two)*

GENERAL SPECIFICATIONS

Operator: France
National designation: FASM 67 (FASM = frégates anti-sous-marins)

Class: TOURVILLE

Built: 3
Active: 3

Displacement:
standard: 4,580 t
full load: 5,950 t

Dimensions
Length: 152.8 m (501.6 ft)
Beam: 16 m (52.4 ft)
Draught: 5.7 m (18.7 ft)

Speed: 32 kts
Range: 5,000 n miles at 18 kts

Complement: 301 (21 officers)

SHIPS

TOURVILLE (D 610)
Builder Lorient Naval Dockyard, France
Laid down 16 Mar 1970
Launched 13 May 1972
Commissioned 21 Jun 1974

DUGUAY-TROUIN (D 611)
Builder Lorient Naval Dockyard, France
Laid down 25 Feb 1971
Launched 1 Jun 1973
Commissioned 17 Sep 1975

DE GRASSE (D 612)
Builder Lorient Naval Dockyard, France
Laid down 14 Jun 1972
Launched 30 Nov 1974
Commissioned 1 Oct 1977

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Exocet MM 38 medium-range anti-ship missile

There are six ITS container-launchers for MM 38 Exocet in two groups of three on the after end of the bridge structure, facing outwards, rather than across the ship, as is more usually the case. Targets are acquired by the ship's search radar and the operator then aligns the axial gyros in the target's direction and begins the initiation sequence. This involves turning on the thermal battery, releasing the mechanical safety locks, igniting the booster and, finally, breaking the umbilical cord; the total process takes some 60 seconds. Exocet has a 105° off-axis engagement envelope and can perform one 15° change of course during its flight.

The attack consists of three phases:

Cruise phase. The cruise phase starts as the missile clears the container and, powered by the sustainer motor, flies towards the general location of the target at a height of about 100 m (328 ft) which is low enough to reduce the chance of detection but adequate for target acquisition. This phase can be as long as 22 km and ends when the seeker acquires the target. This seeker is a Dassault Electronique ADAC (Auto Directeur Anti-Clutter) active monopulse radar, working in the I-band (8-10 GHz), which has a typical range of 13 n miles (24 km) against FACs.

Approach phase. On detecting the target the missile descends to 9-15 m (30-50 ft) in the approach phase.

Terminal phase. During this final phase the missile descends to 8 m (25 ft) (2-5 m (7-16 ft) in a calm sea) for a sea-skimming run in to the target.

A salvo may be fired in 12-20 seconds.

Specifications

(MM 38)
Length: 5.21 m (17.1 ft)
Diameter: 35 cm (13.8 in)
Wing span: 1.00 m (3.28 ft)
Weight: 735 kg (1,620 lb)
Speed: Mach 0.9
Range: 2-22.5 n miles (4-42 km)
Guidance: Inertial and active radar
Sustainer motor: SNPE Eole alloy-cased CDB; weight 151 kg (333 lb); max burn time 93 s.
Booster: 100 kg SNPE Epervier boost motor, burn time of 2.4 s
Warhead: Luchaire 165 kg fragmentation warhead
Fuzes: Delayed impact fuze and autopilot-controlled proximity fuze

Manufacturer/Contractor

Aerospatiale Tactical Missiles, Chatillon Cedex, France.

Thomson-CSF Crotale Naval EDIR

There is one, eight-cell launcher for Thomson-CSF Crotale Naval EDIR located on the hangar roof, with the magazine below. The system comprises a combined director and missile-launching mounting, a fire-control room with supporting electronics and a supervising console in the combat information centre. There is also a missile handling and storage system. The system obtains search information from the DRBV 51 radar, while the director's own sensors are a two-axis stabilised Castor radar antenna, a missile guidance antenna, an infra-red localiser and a TV for low-level tracking. The localiser is designated *Ecartometrie Differentielle Infra-Rouge* (EDIR), while the R440N missile, which attains a speed of Mach 2.3 some 2.5 seconds after launch, can manoeuvre at up to 25 *g* in each axis. System reaction time from target acquisition to launch is a minimum of 4.5 seconds and an average of 6 seconds and maximum range against a helicopter-type target is 13 km, but against high-speed manoeuvring targets such as fixed-wing aircraft or missiles it is between 6.5 and 10.5 km. The system is capable of intercepting four separate targets simultaneously and there are two types of fuze: infra-red (V3N) and RF (V3S). The J-band monopulse radar has a peak power of 80 kW to give it a range in excess of 8.5 n mile (16 km) and has an accuracy of 0.3 mrad in tracking and 0.1 m in missile-to-target differential deviation measurement. The RIC has a deviation measurement accuracy of 1 mrad and is designed to gather the Crotale missile for the command link.

Specifications

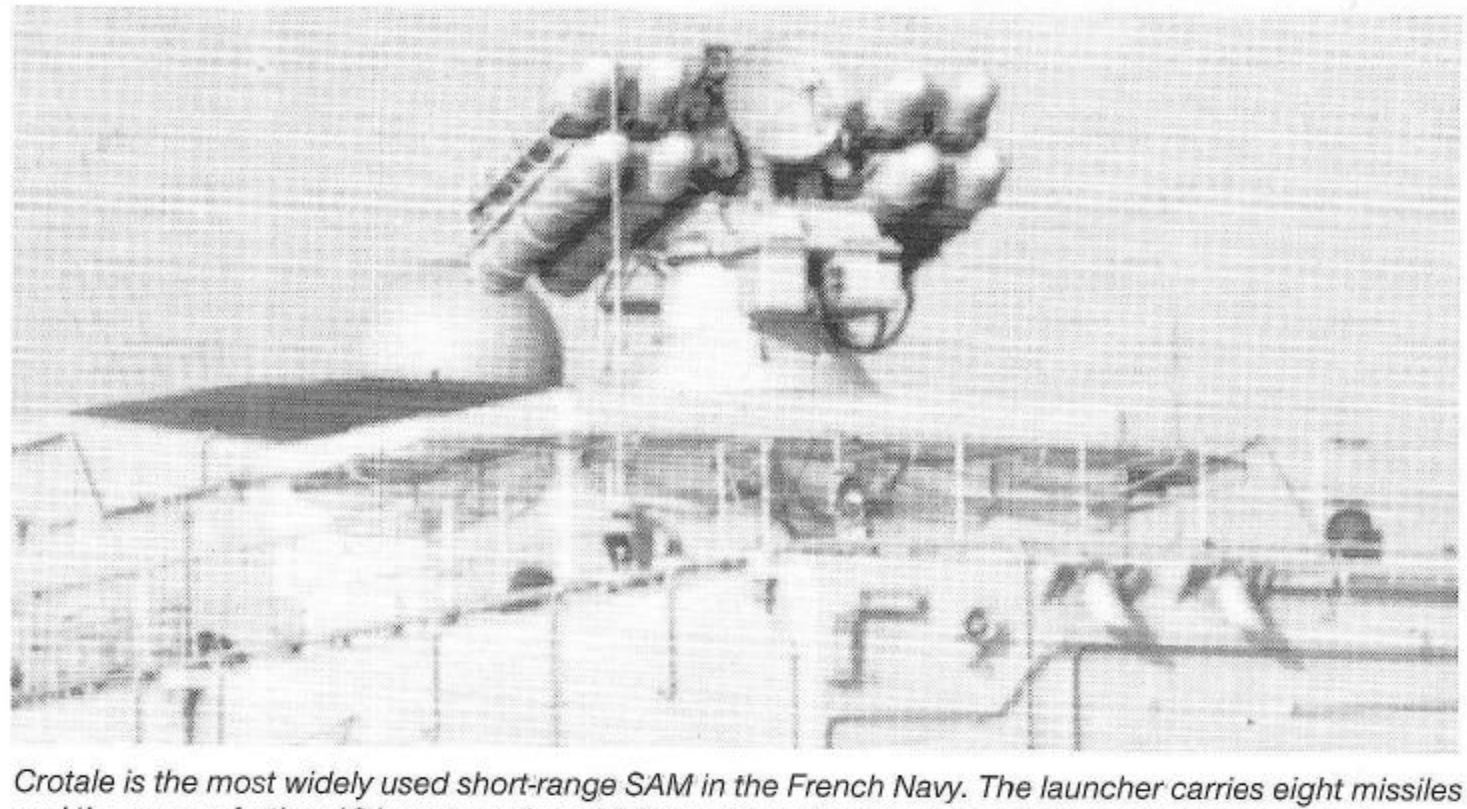
Missile R440N
Length: 2.9 m (9.5 ft)
Diameter: 16 cm (6.3 in)
Wing span: 54 cm (21.25 in)

Weight: 84 kg (185.2 lb)
Speed: Mach 2.4
Warhead: 14 kg (30.9 lb)
Lethal radius: 8 m (26.25 ft)
Range: 700 m to 13 km (766 to 14,230 yd)
Altitude: 4,000 m (13,120 ft)

Launcher-director
Weight: 6.5 t
Traverse: 360°

Sensor
Elevation: −25 to +85°
Radial velocity: 2 rad/s azimuth; 3 rad/s elevation

Mounting
Radial velocity: 1.5 rad/s azimuth; 1 rad/s elevation



Crotale is the most widely used short-range SAM in the French Navy. The launcher carries eight missiles and there are a further 16 in a magazine which must be reloaded by hand. The radar tracker is in the centre of the mounting and the IR tracker can be seen to its left (H & L van Ginderen Collection)

TORPEDOES

There are two fixed torpedo launchers, one on each side, located in the superstructure, abaft the mack. Ten ECAN L5 ASW torpedoes are carried.

ECAN L5 Mod 4 533 mm (21 in) torpedoes

L5 is a heavyweight ASW torpedo, which can be used for direct or indirect attacks. The weapon is of conventional design with a light alloy body, four fins and twin contra rotating propellers, and a blunt nose made of a laminated material. The torpedo is electrically propelled using silver-zinc batteries. They have passive/active seekers which have various operating modes including direct attack or programmed search.

Specifications

(5 Mod 4)
Length: 4.4 m (14.43 ft)
Diameter: 533.4 mm (21 in)
Weight: 935 kg (2,061 lb)
Speed: 35 kts
Range: 5 n miles (9.54 km)
Depth: 555 m (1,820 ft)
Warhead: 150 kg (331 lb)

Manufacturers/Contractors

DCN International (prime).
ECAN, Saint Tropez, France.

GUNS

100 mm/55 Modèle 1968

There are two single 100 mm/55 Modèle 1968-II CADAM dual-purpose mountings located on the foredeck ('A' and 'B' positions). These are normally operated in the fully automatic remote mode with an unmanned turret, although there is a fall-back manual mode, which requires two men in each turret. The turrets have been taken from an old ship and upgraded to CADAM *(CADence AMéliorée)* standard with improved recoil and feed systems, raising the firing rate from 60 rds/min to 78 rds/min.

Specifications

Calibre: 100 mm
Length of barrel: 55 calibres
Muzzle velocity: 870 m/s
Traverse: 360° at 40°/s
Elevation: −15 to +80° at 25°/s
Mounting weight: 21 t
Crew: 2 (optional) and 2 loaders
Range:
anti-surface: 9.15 n miles (17 km)
anti-air: 8,000 m (26,000 ft)
Rate of fire: 78 rds/min
Ammunition: 13.5 kg (multipurpose projectile); 9.7 kg (charge)

Manufacturers/Contractors

Direction des Constructions Navales (DCN) (prime).
Mécanique Creusot-Loire, Marine Products (mountings).
DCN Ruelle (gun).
CSEE, Défense (servo equipment).

Oerlikon 20 mm cannon

There are two single Oerlikon 20 mm cannon on Mk 2 mountings.

Specifications

Calibre: 20 mm
Length of barrel: 70 calibres
Muzzle velocity: 835 m/s
Range:
anti-surface: 1.5 km
anti-air : 1,150 m (3,800 ft)
Rate of fire: 750 rds/min
Round weight: 241 g
Projectile: 122 g
Elevation: −15 to +90°

Duguay-Trouin *(D 611) was refitted as a flagship as recently as 1992-93 but is to be retired in 1999. There are two 100 mm (3.9 in) guns in 'A' and 'B' positions and six MM 38 Exocet just before the mack. On the bridge roof is a DRBC-32D fire-control radar for the guns and an INMARSAT satellite receiver. The short mast behind INMARSAT is topped by a Racal-Decca Type 1226 radar antenna, while at the base of the mast is what appears to be a jammer* (H & L van Ginderen Collection)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thomson-CSF ARBR 16, radar warning

ARBR 16 is an analysis receiver associated in this installation with the ARBB 32 jammer and the Syllex chaff system (see below). It detects radio frequency signals (pulse, continuous wave and frequency hoppers) and compares them with a 1,000-signal library, giving an audio signal where analysis indicates that jamming is necessary. There is a single omnidirectional antenna plus six direction-finding antennas.

Manufacturer/Contractor
Thomson-CSF, Paris Cedex, France.

ELECTRONIC COUNTERMEASURES (ECM)

ARBB 32B

ARBB 32B is a somewhat elderly and relatively unsophisticated jammer that is still installed in some of this class. It is being replaced by the ARBB 36.

Manufacturer/Contractor
Dassault Electronique, Saint Cloud, France.

DECOYS

CSEE Syllex

2 CSEE/VSEL Syllex 8-barrelled trainable launchers (to be replaced by 2 Dagaie systems); chaff to 1 km in centroid and distraction patterns.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

SENIT 3 action data automation

SENIT 3 *(Système d'Exploitation Navale des Informations Tactiques)* was developed specifically for ASW ships and entered service with *Aconit* in March 1973. Like SENIT 1, 2 and 4, SENIT 3 uses mainframe computers and CS-1 software language. There are two computers, versions of the Paramax CP-642 (US designation AN/UYK-20), a 32-bit processor with a 96 k memory which is capable of 125 Kops. They are supported by a control desk, a magnetic tape unit and a paper tape unit. The system is capable of monitoring 128 tracks simultaneously.

The general purpose computer is designed to store tactical situation data and transmit the relevant data to the display systems and, through weapon control consoles, to weapons. In addition to running the display systems the computer transmits tactical situation data via communications links (Link 11 and Link 14) to other elements of the task group.

In the 'Tourville' class SENIT 3 uses ten Hughes AN/UYA-4 consoles, which were manufactured under licence by Thomson-CSF. They have a 30 cm PPI display for the presentation of raw video data and also for the presentation of a synthetic picture. Each display can present up to 70 tracks and 96 symbols together with a marker and a close control symbol as well as alphanumeric data. There is also a PLAD automatic plotting table and four smaller screens presenting alphanumeric data.

Manufacturer/Contractor
DCNI/ISC.

RADARS

Type	DRBV 26	DRBV 51B	DRBN 32 (Decca 1226) (two)	DRBC 32D (Castor I)	Crotale
Role	air search	air search (low level and Exocet target designation)	one for navigation; one for close-range helicopter control	fire control	fire control
Band	D	G	I	I	J
Beam	2.5 × 8.3 csc² to 50°	—	1.2°	1.5°	—
Peak Power	2 MW	200 kW	25 kW	175 kW	—
Gain	29 dB	—	30 dB	37 dB	—
Pulsewidth	2.5 µs	0.6 µs	0.05/0.25/1.0 µs	0.4 µs	—
PRF	450 pps	varied	n/a	4,000-8,000 pps	—
Scan rate	7/15 rpm	30 rpm	28 rpm	—	—
Typical range	150+ n miles on 10 m² target		48 n miles	—	20,000 m
Manufacturer/ Contractor	Thomson-CSF, France	Thomson-CSF, France	Racal Decca, UK	Thomson-CSF, France	Thomson-CSF, France

COMMUNICATIONS AND DATALINKS

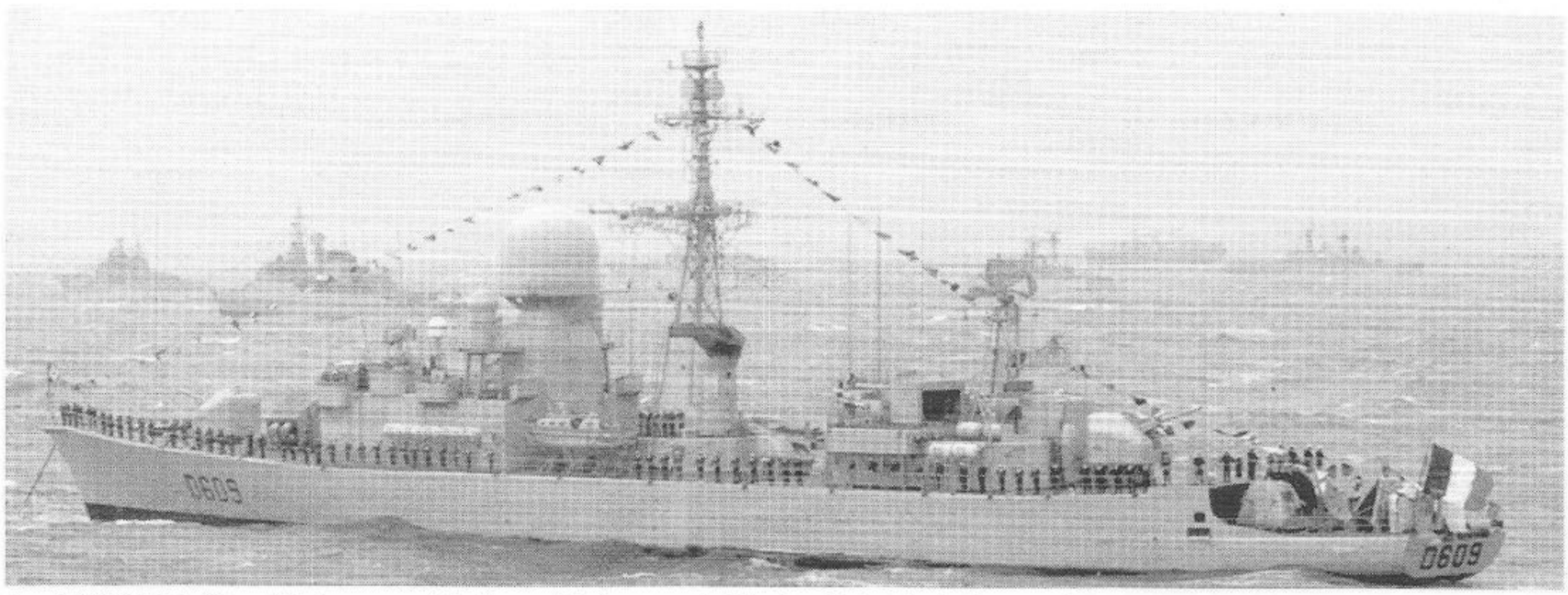
Datalinks: Link 11; Link 14, JMCIS (in D 611)
Satcom: Syracuse 1 or 2

SONAR

SLASM anti-submarine combat system

SLASM was installed in *Tourville* between March 1994 and April 1995, and in *De Grasse* between May 1995 and August 1996, replacing the previous fit of DUBV 23, DUBV 43 and DSBV 62C, which will be retained by *Duguay-Trouin,* until it is retired in 1999. SLASM *(Systeme de Lutte Anti-Sous-Marin)* is an ASW system designed to detect submarines beyond the range of anti-ship weapons. The system integrates the ship's active and passive detection systems, both shipborne and airborne, as well as ASW weapons to provide long-range active and passive detection, short-range active detection, sonar interception and a torpedo-warning capability. It also enables the ships to conduct attacks upon submarines rapidly after detection.

The sensor fit replaces both the DUBV 23 bow-mounted active search attack sonar and the DUBV 43 variable depth sonar (VDS) with a new SLASM active/passive sensor suite. This includes a 15 t towed body made of GRP and housing a very low-frequency (VLF) transmitter operating in the region of 1 kHz, and a low-frequency (LF) (5 kHz) transceiver. This towed body also tows a VLF receiver and a torpedo warning receiver. The VLF sensor is for long-range detection and the MF one for short-range detection. The transducers are in two vertical panels which cover an arc of 120-150° on either side. A lighter weight towed body (SLASM 2) is being considered for the 'Georges Leygues' class.



Aconit *(D 609). The 'Tourville' class was originally meant to be a repeat of the* Aconit, *but the design grew from 3,900 t to 5,950 t and resulted in a totally new design.* Aconit *itself has fallen victim to the latest round of French defence cuts and was retired in late 1996* (H & L van Ginderen Collection)

AVIATION

AVIATION FACILITIES

Specifications

Flight deck: 22 × 16 m (71 × 52 ft)
Hangar: Accommodates two helicopters

HELICOPTERS

The 'Tourville' class carries two Westland Lynx Mk 4 (FN), which are dual roled, either for the ASW mission, carrying sonar or sonobuoy dispenser and ASW weapons, or in the anti-ship role, carrying AS 12 anti-ship missiles. 12 Honeywell Mk 46 torpedoes are carried for use by the helicopters.

Specifications

Main rotor diameter: 12.80 m (42.00 ft)
Tail rotor diameter: 2.21 m (7.25 ft)
Length overall (rotors turning): 15.165 m (49.75 ft)
Width overall, main rotor blades folded: 2.94 m (9.65 ft)
Height overall, both rotors stopped: 3.48 m (11.42 ft)
Weights:
basic: 3,030 kg (6,680 lb)
operating, ASW role: 3,343 kg (7,370 lb)
reconnaissance (crew of two): 3,277 kg (7,224 lb)
dunking sonar search and strike: 3,650 kg (8,047 lb)
take-off (max): 4,763 kg (10,500 lb)
Performance (max take-off weight, sea level, ISA)
cruising speed: 125 kts (232 km/h)
max endurance: 70 kts (130 km/h)
rate of climb: 661 m (2,170 ft)/min
hovering ceiling: 2,575 m (8,450 ft)
max range: 320 n miles (593 km)
max endurance: 2 h 50 min
Power plant: 2 Rolls-Royce Gem Mk 42-1 turboshafts, each with max contingency rating of 835 kW (1,120 shp)
Radar: Omera 31 search and tracking radar
Mission equipment: Alcatel DUAV 4 dipping sonar and Sextant Avionique MAD; Matra AF 530 or APX-334 stabilised sight
Weapons: ASW armament of two 46 homing torpedoes, one each on an external pylon on each side of fuselage, and six marine markers; or two depth charges. Four AS.12 or similar wire-guided missiles

SA-365 Dauphin 2 on the flight deck of Duguay-Trouin *(D611)* (ECPA)

PROPULSION

Specifications

System: Steam turbines
Main machinery: 4 boilers; 45 kg/cm² (640 psi); 450°C (840°F); 2 Rateau turbines; 43 MW (58,000 hp (m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

These three ships were originally intended to be further units of the C 65 (later F 65) 'Aconit' design.

DESIGN

The design was originally intended to be a virtual repeat of the F-67 design, but it was decided to give them two, instead of one, shafts to improve performance and manoeuvrability. It was also decided to add a flight deck and hangar of sufficient size to accommodate two Westland Lynx helicopters, the first such installation in a French destroyer.

As built, the 'Tourville' class was armed with the Malafon ASDW missile system, but this was removed in 1993-1996. The class was also designed to have the Crotale SAM system although, since this was not ready for service at the same time as the ships, the first two entered service with a third 100 mm mounting on the hangar roof, while the third ship had neither gun nor missile system. The Crotale mountings were eventually installed between 1979 and 1981.

During the first decade of service it was found that longitudinal hull stresses were causing problems and a prominent additional steel strake had to be added just below the upper deck level in the late 1970s.

MODERNISATION

De Grasse completed a major refit September 1981, followed by *Duguay-Trouin* in 1984-85. Other work has included fitting passive towed arrays to all three ships in 1990.

Duguay-Trouin (D 611) was modernised between February 1993 and April 1994 and fitted out as a Flagship, which included major communications and combat data systems updates. Another feature of the work was the conversion of part of the accommodation to house 30 females. Despite this, the ship has been selected as the first of the class to be retired in 1999.

The other two ships have both received the SLASM ASW combat suite: *Tourville* (D 610) from March 1994 to April 1995 and *De Grasse* (D 612) from May 1995 to August 1996. This programme includes new bow sonars plus VLF towed active sonar with a separate towed passive array and Murène torpedoes launched from both helicopters and the ships' torpedo launchers.

The Malafon systems were removed from *Duguay-Trouin* in 1993, *Tourville* in 1994 and *De Grasse* in 1996 and it is possible that this may be replaced by the OTOBREDA/Matra Milas standoff delivery vehicle, but not before 1999 at the earliest.

DESIGNATION

These three ships were originally classified as 'corvettes', but were reclassified as '*frégates anti-sous-marins* (FASM),' on 8 July 1971 while still building. Despite this, they were given 'D' pennant numbers like destroyers.

OPERATIONAL

All assigned to GASM. Helicopters are dual roled either with sonar or sonobuoy dispenser and ASW weapons, or AS 12 anti-ship missiles.

FUTURE

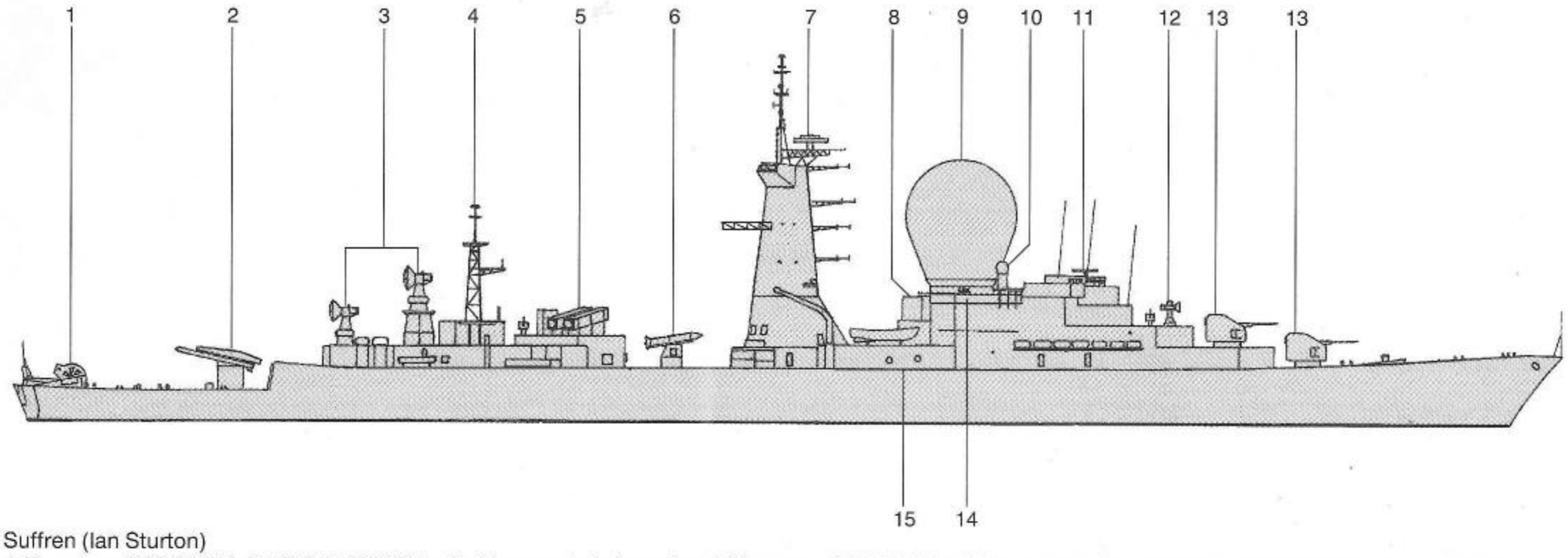
The service lives of these ships were officially due to end:

Tourville — 2000
Duguay-Trouin — 2001
De Grasse — 2003

In early 1996 they were due to be extended by a further decade to 2009-2011 but with continuing defence cuts this plan may be in jeopardy.

Tourville *(D 610) nameship of the class of three which was built between 1970 and 1977. They are large ships, displacing 5,950 t* (H & L van Ginderen Collection)

SUFFREN



Suffren (Ian Sturton)

1 *Thomson-CSF DUBV 43 VDS* **2** *ECAN Ruelle Masurca twin launcher* **3** *Thomson-CSF DRBR 51 fire control (for Masurca)* **4** *VRN-20 Tacan* **5** *MM 38 Exocet launchers (four)* **6** *Latecoere Malafon ASW missile launcher* **7** *DRBV-15A radar (air/surface search)* **8** *ARBB-33 jammer* **9** *DRBI-23 radar (air search)* **10** *Syracuse I Satcom (two)* **11** *Racal-Decca 1226 radar (navigation)* **12** *Thomson-CSF DRBC-33A fire control (for guns)* **13** *Modèle 64 100 mm (3.9 in)/55 KADAM automatic gun mounting* **14** *Dagaie chaff/decoy launcher (two)* **15** *533 mm (21 in) torpedo launchers (two on each side)*

GENERAL SPECIFICATIONS

Operator: France
Type: FLM (Frégates lance-missiles) (see Further Information in this entry)

Class: SUFFREN

Built: 2
Active: 2

Displacement:
standard: 5,090 t
full load: 6,910 t

Dimensions
Length: 157.6 m (517.1 ft)
Beam: 15.5 m (50.9 ft)
Draught: 6.1 m (20 ft)

Speed: 34 kts
Range: 5,100 n miles at 18 kts; 2,400 n miles at 29 kts

Complement: 355 (23 officers)

SHIPS

SUFFREN (D 602)
Builder: Lorient Naval Dockyard, Lorient, France
Laid down 21 Dec 1962
Launched 15 May 1965
Commissioned 20 Jul 1967
Major refit May 1988-Sep 1989

DUQUESNE (D 603)
Builder Brest Naval Dockyard, Brest, France
Laid down 1 Feb 1965
Launched 12 Feb 1966
Commissioned 1 Apr 1970
Major refit Jun 1990-Mar 1991

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Exocet MM 38 medium-range anti-ship missile

There are four ITS container-launchers in two pairs atop the after deckhouse for MM 38 Exocet. These launcher-containers point across the hull at an angle of about 40° and are raised at an angle of 12° to the horizontal. Targets are acquired by the ship's search radar and the operator then aligns the axial gyros in the target's direction and begins the initiation sequence. This involves turning on the thermal battery, releasing the mechanical safety locks, igniting the booster and, finally, breaking the umbilical cord; the total process takes some 60 seconds. Exocet has a 105° off-axis engagement envelope and can perform one 15° change of course during its flight.

The attack consists of three phases:

Cruise phase. The cruise phase starts as the missile clears the container and, powered by the sustainer motor, flies towards the general location of the target at a height of about 100 m (328 ft) which is low enough to reduce the chance of detection but adequate for target acquisition. This phase can be as long as 11 n miles (22 km) and ends when the seeker acquires the target. This seeker is a Dassault Electronique ADAC *(Auto Directeur Anti-Clutter)* active monopulse radar, working in the I-band (8-10 GHz), which has a typical range of 13 n miles (24 km) against FACs.

Approach phase. On detecting the target the missile descends to 9-15 m (30-50 ft) in the approach phase.

Terminal phase. During this final phase the missile descends to 8 m (26 ft) (2-5 m (6-16 ft) in a calm sea) for a sea-skimming run in to the target.

A salvo may be fired in 12-20 seconds.

Specifications

(MM 38)
Length: 5.21 m (17.1 ft)
Diameter: 35 cm (13.8 in)
Wing span: 1.00 m (3.3 ft)
Weight: 735 kg (1,620 lb)
Speed: Mach 0.9
Range: 2-22.5 n miles (4-42 km)
Guidance: Inertial and active radar
Sustainer motor: SNPE Eole alloy-cased CDB; weight 151 kg (333 lb); max burn time 93 s.
Booster: 100 kg SNPE Epervier boost motor, burn time of 2.4 s
Warhead: Luchaire 165 kg (364 lb) fragmentation warhead
Fuzes: Delayed impact fuze and autopilot-controlled proximity fuze

Manufacturer/Contractor

Aerospatiale Tactical Missiles, Chatillon Cedex, France.

SURFACE-TO-AIR MISSILES (SAM)

MASURCA Mk 2 Mod 3 area defence SAM system

There is a single, twin-arm launcher for the MASURCA SAM system sited aft on the quarterdeck. MASURCA *(MArine SUpersonique Ruelle Contre Avions)* was developed in the late 1960s and the only examples still in service are the Mod 3s aboard the two 'Suffren' class ships. MASURCA is a two-stage missile, with a launcher-missile handling system, two DRBR 51 tracker-illuminators, and a weapon direction and fire-control system. The system uses semi-active homing, with a Thomson-CSF I/J-band (8-20 GHz) seeker and two antenna systems. One system, sited in the nose, receives signals reflected from the target, while two fixed antennas further back on the missile body are used to receive the illuminating radar signals directly. The latter provide a reference signal which can be compared with the signals received by the nose antenna, from which a Doppler component can be extracted and used in the onboard computation of a proportional navigation interception course to the target.

The launcher-handling system, produced by ECAN Ruelle, includes a twin-ramp launcher with 360° traverse. Each ramp is served by a horizontal reloading drum and both drums are reloaded from a central magazine. There is a total of 48 missiles: 18 on each drum and 12 in the magazine.

The DRBR 51 tracker-illuminator is a G/H-band (4-8 GHz) radar whose director has three antennas and a TV camera for low-level tracking. The main H-band antenna tracks and illuminates the target and also tracks the missile. A second G-band antenna transmits command signals to ensure the missile remains on the line of sight until the onboard seeker is activated. The third, broad beam antenna is used to gather the missile after launch. Two missiles may be tracked by each director simultaneously.

The weapon direction and fire-control system uses an IBM computer. Targets are acquired and designated

by the DRBI 23 D-band radar which has a peak power of 2 MW. This radar also has a VED 1/ VCS 1 video extractor and AN/USQ-20 computer.

Specifications
Length: 5.29 m (17.36 ft)
Diameter: 40.6 cm (15.98 in)
Weight: 950 kg (2,094 lb)
Speed: Mach 3
Range: 29.6 n miles (55 km)
Warhead: 98 kg (216 lb) HE
Fuze: Proximity
Booster:
type: SNPE Polka
weight: 1,148 kg (2,610 lb)
length: 3.31 m (10.86 ft)
wing span: 1.5 m (4.92 ft)

Manufacturer/Contractor
DCN, Paris Cedex, France.

ANTI-SUBMARINE MISSILES

MALAFON ASW weapon system
There is a single Malafon launcher located immediately abaft the mack. Malafon is a standoff ASW weapon which entered service in 1965 and consists of a small airframe propelled by two SNPE solid propellant boosters carrying an L4 lightweight acoustic ASW torpedo. The missile is launched from a ramp mounted on a converted gun mounting. Within the magazine are 13 missiles which are automatically moved to the launch ramp by an electrohydraulic system.

The missile is powered by two solid fuel booster rockets which fire for 3 seconds to accelerate the missile to 830 km/h (515 mph), following which it glides at a height of 100 m (328 ft) to an area some 800 m (2,625 ft) from the target's estimated position. A tail parachute is then deployed, which decelerates the missile and separates the torpedo from the airframe and the torpedo enters the water to complete the terminal guidance phase of the attack by acoustic homing.

The DCN L4 torpedo was designed to attack submerged submarines travelling at speeds below 20 knots and is capable of operating in shallow water and attacking submarines from periscope depth down to 300 m (984 ft), and, with minor modifications, can also be used against surface vessels. Sonar is used for detection and designation of submerged targets and radar for surface targets and data from these sensors are used during the flight of the missile to provide target data for the generation of command guidance signals, which are then transmitted via radio command link to guide the missile.

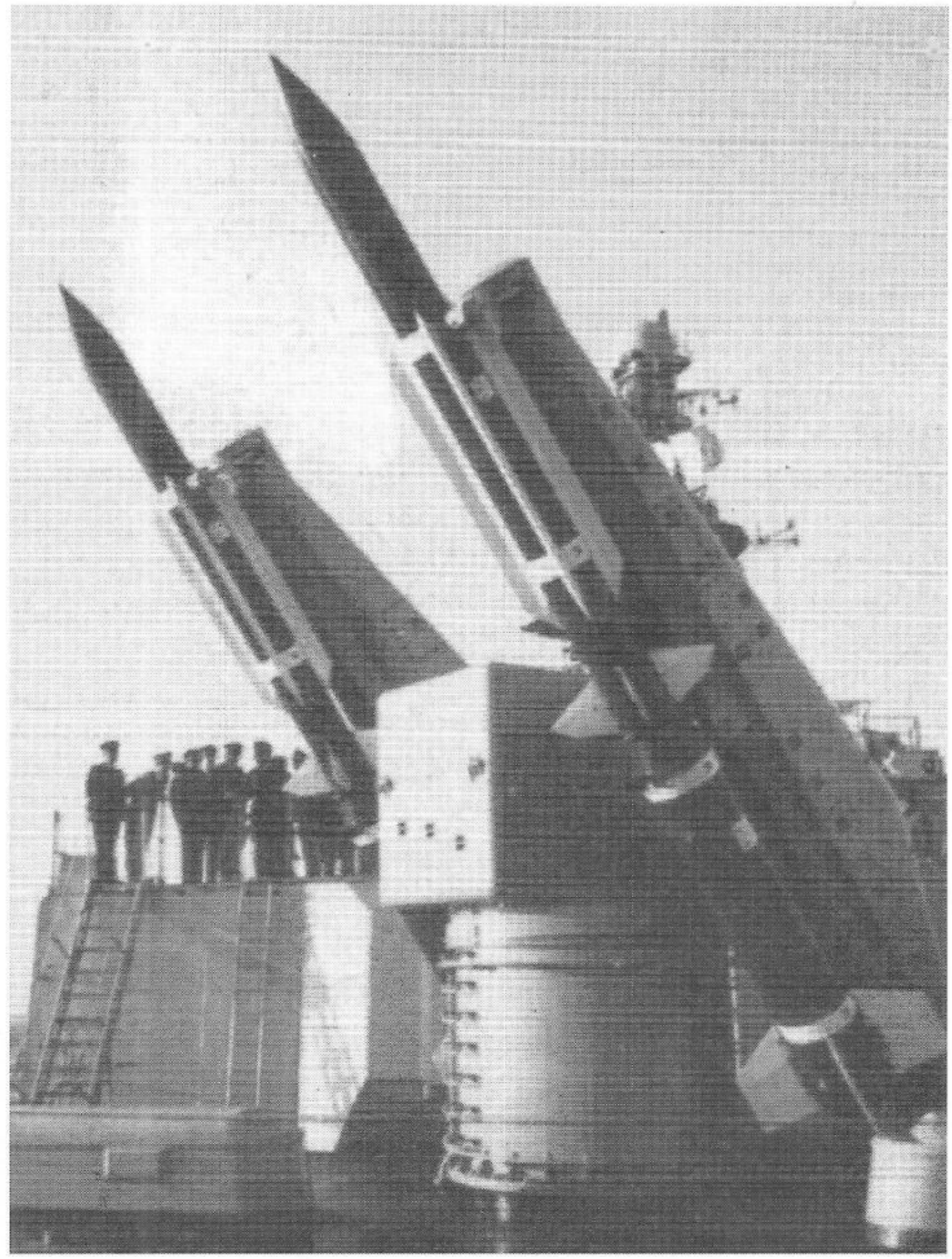
Specifications
Malafon
Length: 6.15 m (20.18 ft)
Diameter: 65 cm (25.6 in)
Wing span: 3.3 m (10.83 ft)
Launch weight: 1,500 kg (3,307 lb)
Range: 7 n miles (13 km)
Speed: 450 kts (830 km/h)

L4 torpedo
Length: 3.13 m (10.26 ft) including parachute stabiliser
Diameter: 533 mm (21 in)
Weight: 525 kg (1,157 lb)
Warhead: 100 kg (220 lb) HE (HBX)
Propulsion: Electric
Speed: 30 kts
Range: 6,000 m (19,700 ft) (approx)
Guidance: Active acoustic homing
Fuze: Impact/acoustic

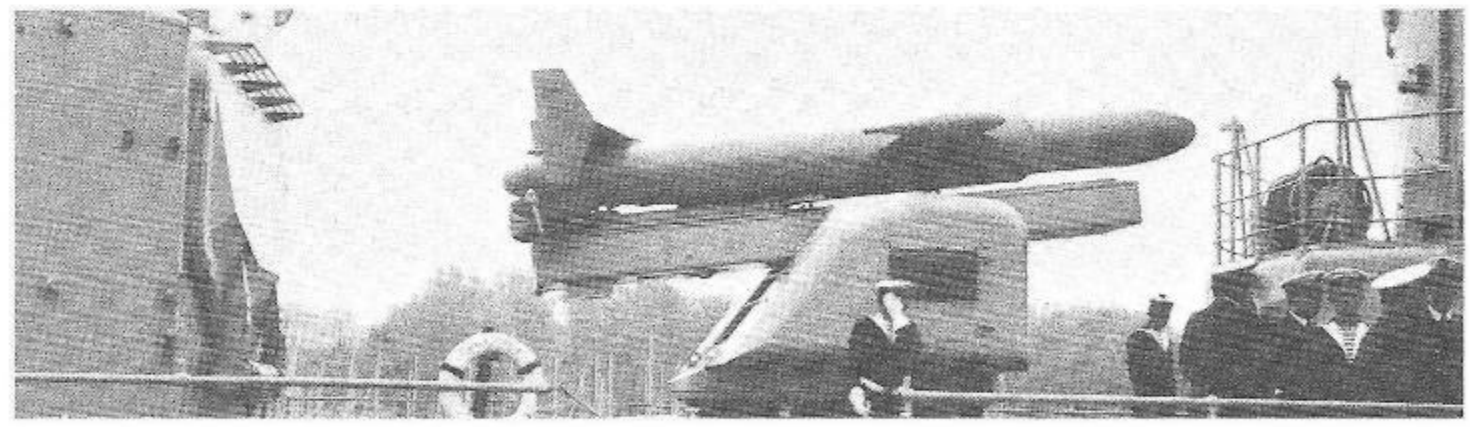
Manufacturer/Contractor
Société Industrielle d'Aviation Latecoere, Toulouse Cedex, France.

TUBES

There are four fixed torpedo launchers, two on each side, located at the after end of the bridge structure. Ten ECAN L5 ASW torpedoes are carried.



MASURCA launcher with two missiles



Malafon ASW missile (Stefan Terzibaschitsch)

TORPEDOES

ECAN L5 Mod 4 533 mm (21 in) torpedoes
L5 is a heavyweight ASW torpedo, which can be used for direct or indirect attacks. The weapon is of conventional design with a light alloy body, four fins and twin contrarotating propellers, and a blunt nose made of a laminated material. The torpedo is electrically propelled using silver-zinc batteries. It has a passive/active seeker which has various operating modes including direct attack or programmed search.

Specifications
(Mod 4)
Length: 4.4 m (14.43 ft)
Diameter: 533.4 mm (21 in)
Weight: 935 kg (2,061 lb)
Speed: 35 kts
Range: 5 n miles (9.54 km)
Depth: 555 m (1,820 ft)
Warhead: 150 kg (331 lb)

Manufacturers/Contractors
DCN International (prime).
ECAN, Saint Tropez, France.

GUNS

100 mm/55 Modèle 1968
There are two single 100 mm/55 Modèle 1968-II CADAM dual-purpose mountings located on the foredeck ('A' and 'B' positions). These are normally operated in the fully automatic remote mode with an unmanned turret, although there is a fall-back manual mode, which requires two men in each turret. The turrets have been taken from an old ship and upgraded to CADAM *(CADence AMéliorée)* standard with improved

recoil and feed systems, raising the firing rate from 60 rds/min to 78 rds/min.

Specifications
Calibre: 100 mm
Length of barrel: 55 calibres
Muzzle velocity: 870 m/s (2,854 ft/s)
Traverse: 360° at 40°/s
Elevation: −15 to +80° at 25°/s
Mounting weight: 21 t
Crew: 2 (optional) and 2 loaders
Range:
anti-surface: 9.15 n miles (17 km)
anti-air: 8,000 m (26,000 ft)
Rate of fire: 78 rds/min
Ammunition: 13.5 kg (multipurpose projectile); 9.7 kg (charge)

Manufacturers/Contractors
Direction des Constructions Navales (DCN) (prime).
Mécanique Creusot-Loire, Marine Products (mountings).
DCN Ruelle (gun).
CSEE, Défense (servo equipment).

Oerlikon 20 mm cannon
There are four or six single Oerlikon 20 mm cannon on Mk 2 mountings.

Specifications
Calibre: 20 mm
Length of barrel: 70 calibres
Muzzle velocity: 835 m/s
Range:
anti-surface: 1.5 km
anti-air: 1,150 m (3,800 ft)
Rate of fire: 450 rds/min
Round weight: 241 g
Projectile: 122 g
Elevation: −15 to +90°

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thomson-CSF ARBR-17
The Thomson-CSF ARBR-17 ESM suite is a high-performance radar detection, analysis and threat warning system, covering conventional radar threat frequencies (that is, C- to J-bands). The system analyses the measured radar parameters and uses these characteristics to determine other parameters such as the radar's type and identity. There are two antenna assemblies, the first being an omnidirectional system installed on the ship's mainmast which provides initial detection and threat frequency, and carries out primary analysis. Below this are two eight-port directional antennas which provide more accurate bearing and frequency information. The antenna assemblies contain preamplifiers for improved performance.

ELECTRONIC COUNTERMEASURES (ECM)

ARBB 33
The ARBB 33 high-performance jammer is able to counter up to four threats simultaneously, including target designation radars as well as pulsed fire-control radars and seeker heads. There is a wide range of jamming modes: continuous noise, pulsed noise, cover pulse jamming, synchronous and asynchronous false echoes, and range gate pull off. The system can be alerted initially by a threat detection equipment, but also possesses an autonomous detection capability. It provides a 360° coverage in azimuth by means of electronically switched antennas for both detection and jamming in order to allow faster reaction time in any direction, the antennas being circular phased arrays for reception and transmission.

The system operates in H-, I- and J-bands and covers two 180° sectors; 36 10° lobes on each side give complete coverage and direction within 5°. Output power is more than 100 kW.

Specifications
Frequency: H-, I- and J-bands
Azimuth coverage: 2 sectors of 180°
Reaction time: <0.5 s
Detection sensitivity: Better than −50 dBm
Bearing accuracy: Better than 5° RMS
Dimensions:
canisters: 1.2 × 2.2 m
cabinet: 1.8 × 0.6 × 0.78 m
Weights:
canisters: 500 kg
cabinet: 400 kg

Two views of Duquesne *(D 603). Top view shows the after end with DUBV-43 VDS launch/recovery gear on the stern with its large 'fish'. Forward of the VDS is the twin-arm launcher for the MASURCA missile system and the associated pair of DRBR 51 fire-control directors. The radomes on the mainmast are a variety of ESM devices. The lower view shows the two single 100 mm (3.9 in) guns on the foredeck with the DRBC-33A fire-control director above. The huge radome stands out, but the tall, thin, fully enclosed 'mack' is equally distinctive. In the well abaft the mack is the Malafon ASW missile launcher, and then the four Exocet launchers atop the deckhouse* (ECPA)

Manufacturer/Contractor
Dassault Electronique, Saint-Cloud, France.

DECOYS

DAGAIE countermeasures system

There are two DAGAIE launchers at the after end of the bridge structure, immediately below the DRBI 23 dome. These can be loaded with either IR or chaff rockets, and the firing sequence runs automatically, once triggered by a missile alarm from a variety of sources, such as radar, ESM systems, or optical sights, thus providing a very short reaction time. The firing direction is optimised in accordance with the threat bearing, wind-speed and direction, ship heading and speed data.

The launching of radar and IR decoys is so arranged that advanced mixed-guidance missile systems cannot discriminate between them and thus collocation of both decoys is achieved. The installation is a double mounting and comprises: (a) two trainable mountings carrying 10 replaceable containers (suitcases), each of which is loaded with either IR or I/J-band chaff projectiles.

A wide range of ammunition is provided by Etienne Lacroix Défense providing seduction, distraction and seduction/ dissimulation modes. The electromagnetic decoys are normally based upon aluminised fibreglass chaff with rapid bloom time and they cover the I and J frequency bands. The infra-red decoys cover both the 3-5 and the 8-14 µm bands.

Specifications

Traverse: 330° at 21°/s
Average reaction time: Within 4 s
REM rocket dimensions: 850 × 127 mm (33.5 × 5 in)
Rocket weight: 13 kg (28.66 lb)
Container dimensions: 900 × 130 mm (35.4 × 5.1 in)
Container weight: 20 kg (44.1 lb)
LIR/LEM container dimensions: 780 × 630 × 134 mm (30 × 24.8 × 5.3 in)
Container weight: 54 kg (119 lb)

Manufacturer/Contractor

CSEE Défense, Paris, France.

CSEE Sagaie

There are two CSEE Sagaie 10-barrelled trainable decoy launchers. SAGAIE *(Système d'Autodèfense pour la Guerre Infra-rouge et Electromagnetique)* is a fully automatic, passive countermeasures system which provides protection against incoming missiles guided by electromagnetic (EM) or infra-red (IR) seekers, or any combination of these two, even when the missiles are attacking simultaneously over the entire horizon. SAGAIE is fully automatic from the reception of a missile threat alarm originating from any of the surveillance systems (radar, IR, optical or ESM) and optimises the use of decoys in a very short reaction time. The equipment can be used alone (confusion and distraction) or jointly with a jammer (dilution, substitution after concealment, substitution after deception) by firing substitution decoys. The installation comprises two fully stabilised launchers loaded with 10 rockets in 30 kg containers and trainable in azimuth and elevation; two servo units; two aiming and maintenance units; and a processing unit which computes the rocket launching sequence and provides information for the supervision unit; a supervision unit with controls and status displays; and an interface unit which provides for operation with any tactical data or target designation system. SAGAIE fires either EM or IR decoy rocket type ammunition or both.

Specifications

Range:
chaff: 4.3 n miles (8 km)
IR flares: 1.6 n miles (3 km)

Manufacturer/Contractor

CS Défense, Courtaboeuf, France.

Stern view of Duquesne *(D 603) showing DUBV 43 'fish', MASURCA launcher and DRBR 61 fire-control directors* (Jane's Radar and Electronic Warfare Systems)

Suffren *(D 602) is instantly recognisable by its huge radome, which houses the DRBI 32 air search radar. The transmitter has no less than six amplifier stages to achieve the power output of 2 MW* (Jane's/H M Steele)

Dassault LAD offboard decoys

Dassault LAD *(Leurre Actif Décale)* is an offboard decoy system, designed to counter radar-guided anti-ship missiles, consisting of an intelligent electronic decoy round, a standard 130 mm calibre multibarrelled launcher and a microprocessor-based fire-control unit. The system interfaces with the ship sensors to give fully automatic, semi-automatic or manual activation of the decoy round, which consists of a low *g* rocket, a parachute, a transmitter, a receiver and antennas, control electronics and a battery source.

Specifications

Length: 900 mm (35.4 in)
Diameter: 127 mm (5 in)
Deployment time: >10 s
Jamming time: <3 min
Power consumption: 2 kW

Manufacturer/Contractor

Dassault Electronique, Saint-Cloud, France.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

SENIT 2 action data automation

SENIT *(Système d'Exploitation Navale des Informations Tactiques)* evolved from the early 1960s through French involvement in the American NTDS. SENIT 2 was a development of SENIT 1 and is designed to compile a tactical picture around major warships and task groups using onboard and offboard sensors, utilising a mainframe computer and CS-1 software language. The general purpose computer is designed to store tactical situation data and transmit the relevant data to the display systems and, through weapon control consoles, to weapons. In addition to running the display systems the computer transmits tactical situation data via communications links (Link 11 and Link 14) to other elements of the task group. SENIT 2 has three computers which are versions of the Paramax CP-642 (US designation AN/UYK-20), a 32-bit processor with a 96 k memory which is capable of 125 Kops. They are supported by a control desk, a magnetic tape unit and a paper tape unit. These three systems are capable of monitoring 128 tracks simultaneously. SENIT 2 uses Hughes AN/UYA-4 consoles which were manufactured under licence by Thomson-CSF, have a 30 cm PPI display for the presentation of raw video data and also for the presentation of a synthetic picture. Each display can present up to 70 tracks and 96 symbols together with a marker and a close control symbol as well as alphanumeric data. SENIT 2 is used in the 'Suffren' class destroyers and the 'Clemenceau' class aircraft carriers.

Manufacturer/Contractor

DCNI/ISC, Paris, France.

RADARS

Type	DRBI 23	DRBV 15A	DRBN 32 (Decca 1226)	DRBR 51 (two)	DRBC 33A
Role	3D air search and target designation for MASURCA SAM	Air/surface search; target designation	One for navigation; one for close-range helicopter control	MASURCA fire control	Fire control for guns
Band	D	E/F	I	G/H	I
Beam	—	csc² up to 50°	1.2°	—	2.45 × 2.3°
Peak Power	2 MW	n/a	25 kW	—	30 kW
Gain	—	30 dB	30 dB	—	36 dB
Pulsewidth	—	n/a	0.05/0.25/1.0 µs	—	0.5 µs
PRF	—	n/a	n/a	—	4-800 pps
Scan rate	—	15/30 rpm	28 rpm	—	—
Typical range	—	P_d <50 per cent against 2 m² target at 60 n miles at heights up 15,240 m (50,000 ft)	48 n miles	16 n miles (30 km) on 2 m² target	16 n miles (30 km) on 2 m² target
Manufacturer/ Contractor	Thomson-CSF, France	Thomson-CSF, France	Racal Decca, UK	Thomson-CSF, France	Thomson-CSF, France

COMMUNICATIONS AND DATALINKS

Datallinks: Link 11, Link 14
Satcom: Syracuse I
Tacan: URN 20.

WEAPONS CONTROL

DCN CTMS radar/optronic control system with SAT DIBC 1A Piranha IR and TV tracker.
2 Sagem DMA optical directors.

SONARS

DUBV 23D medium-frequency search sonar

DUBV 23D is a medium-frequency (5 kHz) panoramic sonar for anti-submarine operations which is operated in conjunction with the DUBV 43 VDS (see below). There is a 48-column transducer array housed in a streamlined bulb at the fore part of the ship. The panoramic sonar is intended for both search and attack roles and, in addition to the transducer array, the equipment includes the transmitter/receiver unit, a computer section for the processing of data being fed to weapons, and control and display consoles at the anti-submarine attack station. The DUBV 23D is of identical design to the towed sonar DUBV 43B/C and the two are used together for anti-submarine warfare. Operating modes provide for: panoramic surveillance, sector surveillance, step surveillance, passive surveillance at sonar frequency, panoramic attack transmission, or 'searchlight' attack transmission. In addition to the system's own display devices, the DUBV 23D provides for target data outputs to other ships' systems and repeater PPIs. The system is no longer in production, but systems in service will be upgraded through the SLASM programme.

Specifications

Transmitter
Frequencies: 4 operating frequencies in the neighbourhood of 5 kHz, of which 2 are operational
Power: 96 kW (2 × 48 kW)
Type: CW, FM (linear frequency modulation with non-coherent data processing at reception)
Duration: 4, 30, 150 or 700 ms
Scatter echo: With or without rejection
Doppler effect correction: On all 48 channels
Cadence: Adjustable step by step from 1,400-44,000 m (1,500-48,000 yd)
Receiver: Panoramic, directional, passive listening in sonar band

Manufacturer/Contractor

Thomson-CSF, Activités Sous-Marines, Sophia Antipolis Cedex, France.

DUBV 43 variable depth sonar

The DUBV 43 medium-frequency Variable Depth Sonar (VDS) comprises a streamlined towed body containing the sonar transducer array. This is towed from the stern at speeds of up to 24 knots and can be set to run at depths down to 200 m (650 ft) in the 'B' version and up to 700 m (3,000 ft) in the 'C' version. It is equipped with stabilisers providing for control in roll, pitch and depth. The submerged weight of the fish is around 8 tonnes. Detection ranges of up to 13 n miles (25 km) are quoted. Length of tow is 600 m (2,000 ft)

Manufacturers/Contractors

Direction des Constructions Navales, Paris, France.
Thomson CSF, Activités Sous-Marines, Sophia Antipolis Cedex, France.

PROPULSION

Specifications

System: Steam turbines
Main machinery: 4 boilers; 45 kg/cm² (640 psi); 450°C (842°F); 2 Rateau turbines; 53 MW (72,500 hp (m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The first French guided missile ships, these two destroyers were ordered under the 1960 programme. They were intended to provide both anti-submarine and anti-air defence for French carrier groups — a similar mission to that for which the British Type 82 destroyer was designed. It was originally intended that there should be an initial class of three, followed by more later, but financial and other considerations resulted in a reduction to just two ships.

DESIGN

This class introduced what was to become the classic French hull form with a high clipper bow, with negative sheer to enable the 'A' position gun to fire dead ahead. They are equipped with gyro-controlled roll dampers which operate three pairs of non-retractable fins, and are excellent sea boats and stable weapons platforms.

The class was designed in the early 1960s at a time when there was very strong pressure to use as little foreign equipment as possible. As a result, the ships' systems are of almost exclusively French origin, with the main missile system being the ECAN MASURCA. NBC citadel fitted during modernisation.

MODERNISATION

The two ships have received regular upgrades to their equipment and both have had a major refit: *Suffren,* May 1988 to September 1989; *Duquesne,* June 1990 to March 1991.

MM 38 Exocet was fitted in 1977 *(Duquesne)* and 1979 *(Suffren)* and the MASURCA system was modernised in 1984-85 *(Duquesne)* and 1988-89 *(Suffren)* with new computers and DRBV 15A radars replaced DRBV 50.

Work during the major refits included: modernisation of the DRBI-23 radar; new computers for the SENIT combat data system; new CTMS fire-control system for 100 mm guns fitted (with DRBC-33A radar, TV camera and DIBC-1A Piranha IR tracker). New ESM/ECM suite: ARBR 17 radar interceptor, ARBB 33 jammer and Sagaie decoy launchers. Two 20 mm guns were also fitted either side of DRBC 33A.

DESIGNATION

These two ships are officially designated '*frégates lance-missiles* (FLM)'. However, they carry destroyer pennant numbers and, with a 6,090 t displacement they are generally regarded as destroyers.

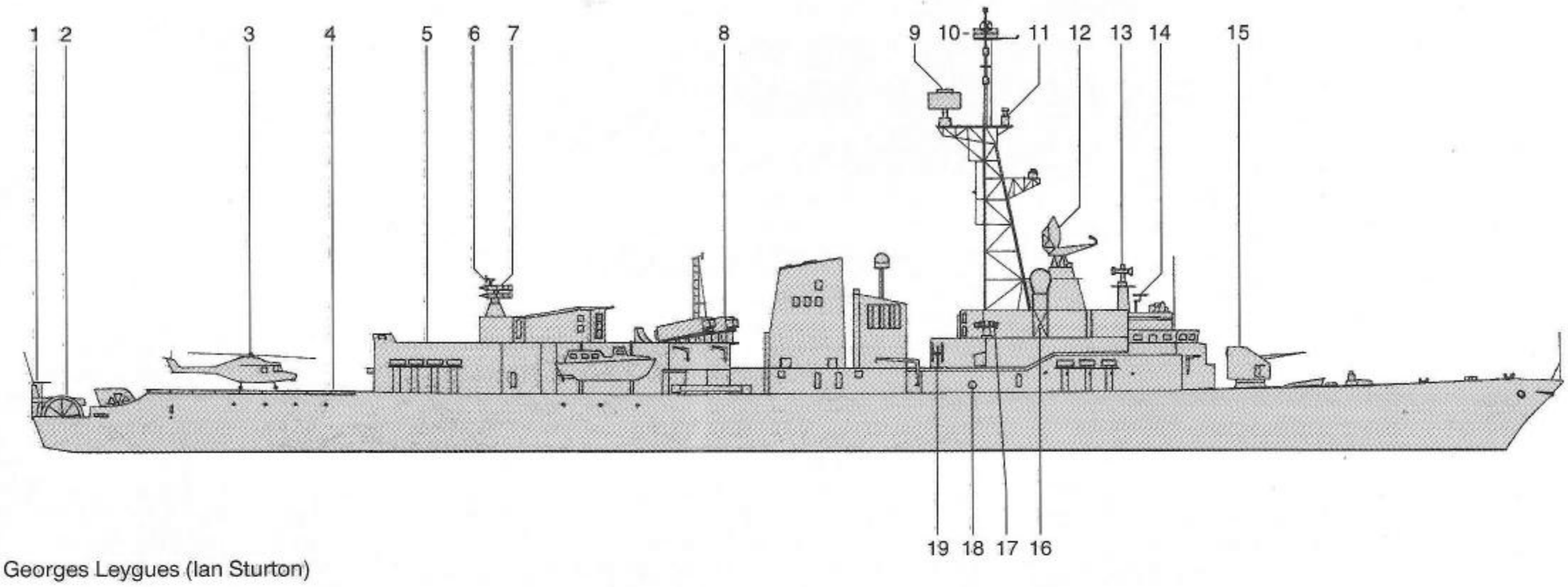
OPERATIONAL

Both ships operate in the Mediterranean under FAN.

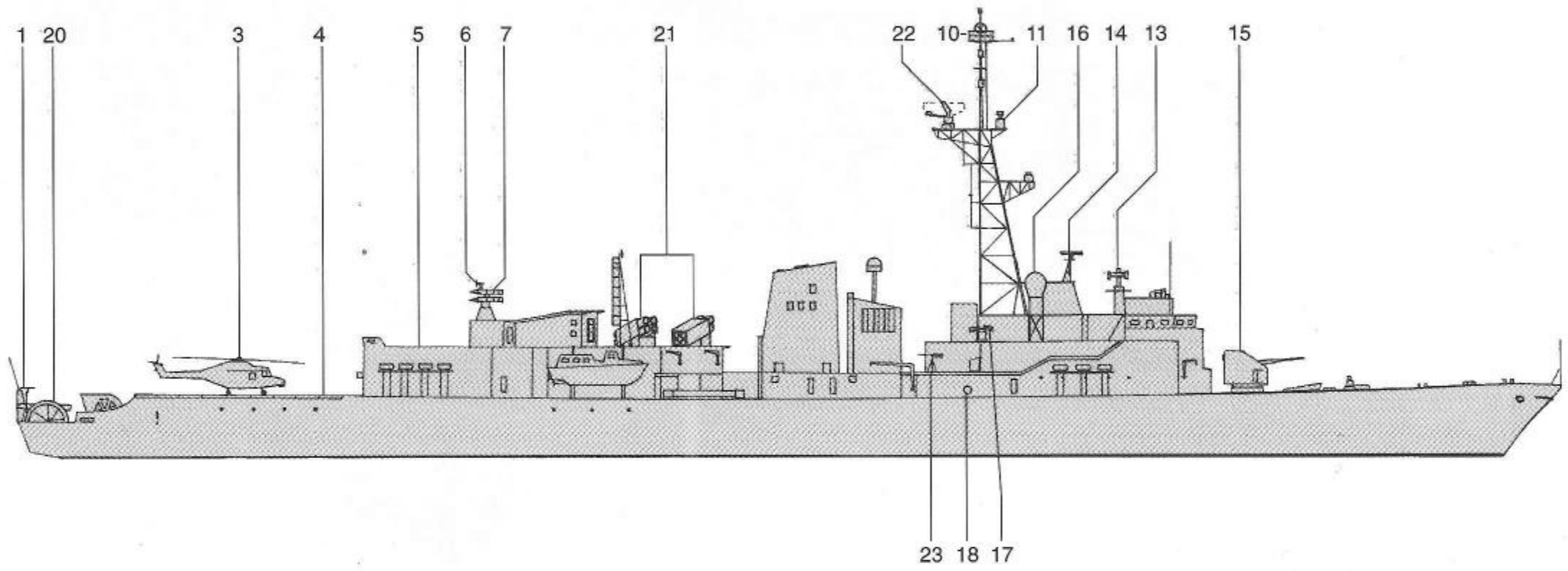
THE FUTURE

Both ships have had their service lives extended to beyond 2000 and are among the ships due to be replaced by the 'Horizon' class in due course.

GEORGES LEYGUES



Georges Leygues (Ian Sturton)



Primauguet (Ian Sturton)

1 *Racal-Decca RM1226 radars (helicopter control)* **2** *DUBV 43B VDS* **3** *WG13 Lynx ASW helicopter (two)* **4** *Flight deck* **5** *Hangar* **6** *Crotale radar* **7** *Crotale Naval EDIR four-arm launcher* **8** *MM 38 Exocet launcher (four)* **9** *Thomson-CSF DRBV-51C radar (air/surface search)* **10** *Saigon* **11** *ARBR-17 radar warning* **12** *DRBV-26 radar (air search)* **13** *DRBC-32E radar (Vega fire-control system)* **14** *Racal-Decca RM 1226 radar (navigation)* **15** *Modèle 68 100 mm (3.9 in) CADAM single gun mounting* **16** *Syracuse Satcom* **17** *CSEE Dagaie chaff/decoy launcher* **18** *KD59E 533 mm (21 in) torpedo launcher* **19** *Matra SADRAL launcher* **20** *DUBV-43C VDS* **21** *MM 40 Exocet launchers (four)* **22** *Thomson-CSF DRBV-15A radar (air/surface search)* **23** *Matra Simbad launchers*

GENERAL SPECIFICATIONS

Operator: France
Type: FASM 70 (FASM = frégates anti-sous-marines)

Class: GEORGES LEYGUES

Built: 7
Active: 7

Displacement:
standard: 3,830 t
full load: D 640-643: 4,300 t; D 644-646: 4,580 t

Dimensions
Length: 139 m (455.9 ft)
Beam: 14 m (45.9 ft)
Draught: 5.7 m (18.7 ft)

Speed:
full power: 30 kts
diesels: 21 kts
Range:
full power: 2,500 n miles at 28 kts
diesels: 8,500 n miles at 18 kts

Complement: 218 (16 officers) plus 16 spare billets

SHIPS

GEORGES LEYGUES (D 640)
Builder Brest Naval Dockyard, Brest, France
Laid down 16 Sep 1974
Launched 17 Dec 1976
Commissioned 10 Dec 1979

DUPLEIX (D 641)
Builder Brest Naval Dockyard, Brest, France
Laid down 17 Oct 1975
Launched 2 Dec 1978
Commissioned 13 Jun 1981

MONTCALM (D 642)
Builder Brest Naval Dockyard, Brest, France
Laid down 5 Dec 1975
Launched 31 May 1980
Commissioned 28 May 1982

JEAN DE VIENNE (D 643)
Builder Brest Naval Dockyard, Brest, France
Laid down 26 Oct 1979
Launched 17 Nov 1981
Commissioned 25 May 1984

PRIMAUGUET (D 644)
Builder Brest Naval Dockyard, Brest, France
Laid down 17 Nov 1981
Launched 17 Mar 1984
Commissioned 5 Nov 1986

LA MOTTE-PICQUET (D 645)
Builder Brest Naval Dockyard/L'Orient, France
Laid down 12 Feb 1982
Launched 6 Feb 1985
Commissioned 18 Feb 1988

LATOUCHE-TREVILLE (D 646)
Builder Brest Naval Dockyard/L'Orient, France
Laid down 15 Feb 1984
Launched 19 Mar 1988
Commissioned 16 Jul 1990

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Exocet MM 38 medium-range anti-ship missile

***(Georges Leygues* (D 640), *Dupleix* (D 641) only.)** Four Aerospatiale MM 38 Exocets are mounted immediately abaft the stack in individual ITS *(Installation de Tir Standard)* launcher-containers, within which they are suspended from a launch rail in the ceiling. These launcher-containers point outwards at an angle of about 75° and are raised at an angle of 12° to the horizontal. Targets are acquired by the ship's search radar and the operator then aligns the axial gyros in the target's direction and begins the initiation sequence. This involves turning on the thermal battery, releasing the mechanical safety locks, igniting the booster and, finally, breaking the umbilical cord; the total process takes some 60 seconds. Exocet has a 105° off-axis engagement envelope and can perform one 15° change of course during its flight.

The attack consists of three phases:

Cruise phase. The cruise phase starts as the missile clears the container and, powered by the sustainer motor, flies towards the general location of the target at a height of about 100 m (330 ft) which is low enough to reduce the chance of detection but adequate for target acquisition. This phase can be as long as 22 km and ends when the seeker acquires the target. This seeker is a Dassault Electronique ADAC *(Auto Directeur Anti-Clutter)* active monopulse radar, working in the I-band (8-10 GHz), which has a typical range of 13 n miles (24 km) against FACs.

Approach phase. On detecting the target the missile descends to 9-15 m (30-50 ft) in the approach phase.

Terminal phase. During this final phase the missile descends to 8 m (26 ft) (2-5 m (7-16 ft) in a calm sea) for a sea-skimming run in to the target.

A salvo may be fired in 12-20 seconds.

Specifications

(MM 38)

Length: 5.21 m (17.1 ft)
Diameter: 35 cm (13.78 in)
Wing span: 1.00 m (3.28 ft)
Weight: 735 kg (1,620 kg)
Speed: Mach 0.9
Range: 2-22.5 n miles (4-42 km)
Guidance: Inertial and active radar
Sustainer motor: SNPE Eole alloy-cased CDB; weight 151 kg (333 lb); max burn time 93 s
Booster: 100 kg SNPE Epervier boost motor, burn time of 2.4 s
Warhead: Luchaire 165 kg (364 lb) fragmentation warhead
Fuzes: Delayed impact fuze and autopilot-controlled proximity fuze

Manufacturer/Contractor

Aerospatiale Tactical Missiles, Chatillon Cedex, France.

Exocet MM 40 anti-ship missiles

***(Montcalm* (D 642) to *La Touche-Tréville* (D 646) only.)** Four MM 40 Exocet ('Flying Fish') anti-ship missiles replace the MM 38 version, previously used. The missile launch canisters are mounted in the same position, abaft the stack. MM 40 is a surface-launched missile with folding wings and rocket boosters and sustainer. The missiles are carried in individual glass fibre launcher-containers which are mounted at an angle of +12°.

There are two versions of MM 40, designated Blocks 1 and 2. Block 2 missiles feature a new J-band (10-20 GHz) seeker with improved ECCM performance, associated electronics and a new guidance computer, although no further details are currently available. The new electronics permit the missile to optimise its sea-skimming height, allowing it to operate in conditions to Sea State 7 even in severe ECM conditions. The fire-control system has also been adapted with the development of the Cat-Visac console which can operate with two types of the Exocet missile simultaneously. The new fire-control system allows improved target selectivity, attacks upon multiple targets by diverging and converging salvos.

Targets for the missiles are acquired by the ship's sensors, and the operator then aligns the axial gyros in the target's direction and begins the initiation sequence which can take up to 60 seconds. Exocet has a 105° off-axis engagement envelope and can perform one 15° change in the course of its flight. Once the missile has cleared the launcher-container, the sustainer carries it into the cruise phase and it then travels towards the general location of the target at a height of about 100 m (330 ft) which is low enough to reduce the chance of detection but adequate for target acquisition. Once the target is detected the missile descends to 9 to 15 m (30 to 50 ft) in the approach phase before descending to 8 m (26.2 ft) (2 to 5 m (6.5 to 16.4 ft) in a calm sea) for a sea-skimming terminal phase. A salvo may be fired in 12 to 20 seconds.

Specifications

	MM 40 Block 1	MM 40 Block 2
Length	5.78 m	5.80 m
Diameter	35 cm	35 cm
Wing span	1.13 m	1.13 m
Weight	855 kg	870 kg
Speed	Mach 0.9	Mach 0.9
Range	2-38 n miles (4-70 km)	2-40.5 n miles (4-75 km)
Warhead	165 kg HE frag	155 kg HE frag
Fuze	delay impact/ proximity	impact/proximity
Guidance	Inertial and active radar	

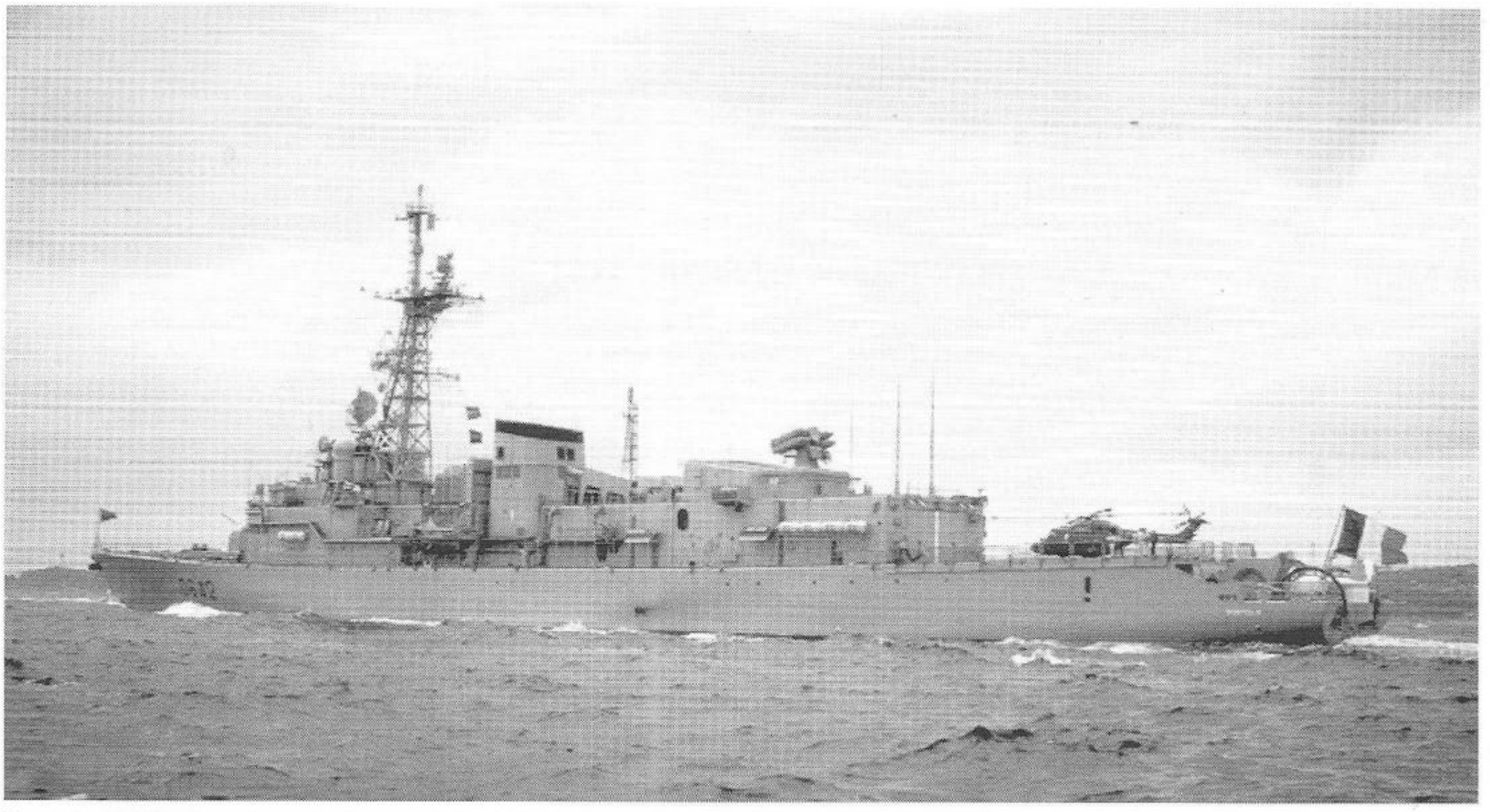
Manufacturers/Contractors

Aerospatiale Missiles, Paris Cedex, France (prime).
Luchaire Défense, Versailles Cedex, France (warhead).

SURFACE-TO-AIR MISSILES (SAM)

Thomson-CSF Crotale Naval EDIR

There is one, eight-cell launcher for Thomson-CSF Crotale Naval EDIR located on the hangar roof, with a 26 missile magazine below. The system comprises a combined director and missile-launching mounting, a fire-control room with supporting electronics and a supervising console in the combat information centre. There is also a missile handling and storage system. The system obtains search information from the search radar, while the director's own sensors are a two-axis stabilised Castor radar antenna, a missile guidance antenna, an infra-red localiser and a TV for low-level tracking. The localiser is designated *Ecartometrie Differentielle Infra-Rouge* (EDIR), while the R440N missile, which attains a speed of Mach 2.3 some 2.5 seconds after launch, can manoeuvre at up to 25 *g* in each axis. System reaction time from target acquisition to launch is a minimum of 4.5 seconds and an average of 6 seconds and maximum range against a helicopter-type target is 13 km, but against high-speed manoeuvring targets such as fixed-wing aircraft or missiles it is between 6.5 and 10.5 km. The system is capable of intercepting four separate targets simultaneously and there are two types of fuze: infra-red (V3N) and RF (V3S). The J-band monopulse radar has a peak power of 80 kW to give it a range in excess of 8.5 n miles (16 km) and has an accuracy of 0.3 mrad in tracking and 0.1 m in missile-to-target differential deviation measurement. The RIC has a deviation measurement



Montcalm *(D 642) shows the major features of the class: single 100 mm (3.9 in) gun on the foredeck; four MM 38 Exocet launchers (abaft the stack); Crotale Naval EDIR eight-cell launcher (hangar roof) and two WG13 Lynx helicopters* (Jane's/H M Steele)

accuracy of 1 mrad and is designed to gather the Crotale missile for the command link.

Specifications
Missile R440N
Length: 2.9 m (9.5 ft)
Diameter: 16 cm (6.3 in)
Wing span: 54 cm (21.25 in)
Weight: 84 kg (185.2 lb)
Speed: Mach 2.4
Warhead: 14 kg (30.9 lb)
Lethal radius: 8 m (26.25 ft)
Range: 700 m to 13 km (766 to 14,230 yd)
Altitude: 4,000 m (13,120 ft)

Launcher-director
Weight: 6.5 t
Traverse: 360°

Sensor
Elevation: −25 to +85°
Radial velocity: 2 rad/s azimuth; 3 rad/s elevation

Mounting
Radial velocity: 1.5 rad/s azimuth; 1 rad/s elevation
Electrical power requirements: 440 V 60 Hz, 115 V 60 Hz, 115 V 400 Hz

Matra Sadral
Two sextuple launchers for Matra Sadral *(Système d'Auto Défense Rapprochée Anti-aérienne Léger)* point-defence missile systems are being installed in the first four ships; (that is, D 640-D 643). This system is designed to counter sea-skimmer missiles and is able to engage targets down to 3 m (10 ft) above sea level.

Specifications
Missile
Guidance: IR homing
Range: 2.2 n miles (4 km)
Warhead: 3 kg (1,500 tungsten balls)

Manufacturer/Contractor
Matra Defense, Velizy-Villacoublay, France.

TORPEDOES

There are two Modèle KD 59E fixed launchers for ECAN L5 ASW torpedoes. 10 torpedoes are carried.

ECAN L5 Mod 4 533 mm (21 in) torpedoes
L5 is a heavyweight ASW torpedo which can be used for direct or indirect attacks. The weapon is of conventional design with a light alloy body, four fins and twin contrarotating propellers, and a blunt nose made of a laminated material. The torpedo is electrically propelled using silver-zinc batteries. There is a passive/active seeker which has various operating modes including direct attack or programmed search.

Specifications
(Mod 4)
Length: 4.4 m (14.43 ft)
Diameter: 533.4 mm (21 in)
Weight: 935 kg (2,061 lb)
Speed: 35 kts
Range: 5 n miles (9.54 km)
Depth: 555 m (1,820 ft)
Warhead: 150 kg (331 lb)

Manufacturers/Contractors
DCN International, Paris, France (prime).
ECAN, Saint Tropez, France (production).

GUNS

100 mm/55 Modèle 1968
The single 100 mm Modèle 1968-II dual-purpose gun is located on the foredeck ('A' position) and is normally operated in the fully automatic remote mode with an unmanned turret, although there is a fallback manual mode, requiring two men in the turret. Many of the older mountings, including those in the 'Georges Leygues' class, have been upgraded to CADAM *(CADence AMéliorée)* standard with improved recoil and feed systems which raise the firing rate from 60 rds/min to 78 rds/min.

Specifications
Calibre: 100 mm
Length of barrel: 55 calibres
Muzzle velocity: 870 m/s
Traverse: 360° at 40°/s
Elevation: −15 to +80° at 25°/s
Mounting weight: 21 t
Crew: 2 (optional) and 2 loaders
Range:
anti-surface: 9.15 n miles (17 km)
anti-air: 8,000 m (26,000 ft)
Rate of fire: 78 rds/min
Ammunition: 13.5 kg (multipurpose projectile); 9.7 kg (charge)

Manufacturers/Contractors
Direction des Constructions Navales (DCN) (prime).
Mécanique Creusot-Loire, Marine Products (mountings).
DCN Ruelle (gun).
CSEE Défense (servo equipment).

Oerlikon 20 mm cannon
Two Oerlikon 20 mm cannon on Mk 2 mountings are located in single, manual mountings at the after end of the bridge structure.

Specifications
Calibre: 20 mm
Length of barrel: 70 calibres
Muzzle velocity: 835 m/s
Range:
anti-surface: 1.5 km
anti-air: 1,150 m (3,800 ft)
Rate of fire: 720 rds/min
Round weight: 241 g
Projectile: 122 g
Elevation: −15 to +90°

Breda 30 mm Mauser 30 Model F Single Compact Mounting
Two of the new Breda/Mauser 30 mountings are being installed in the first four ships of the class in place of the Oerlikon 20 mm mounts. This new weapon (produced under licence by DCN) combines the Mauser 30 Model F, firing the 30 mm × 173 GAU 8/A round with a Breda mounting. It is fully gas-operated, using pistons which not only operate the bolt but, autonomously, the ammunition feed system, and all movable parts such as the return springs, gas piston and buffer are installed along the gun axis to eliminate transverse loads which would have an adverse effect upon gun motion. The breech system consists of dual locking flaps with a long rigid locking time. The weapon uses a floating buffer system so that operation occurs during counter-recoil. Thus, by the time the firing pin strikes the primer of the cartridge the counter-recoil forces are helping to balance the recoil effect. The Single Compact mounting is a scaled-down version of the twin Compact Type C on an 80 cm diameter base and uses two magazine boxes, each of 80 rounds, attached to the trunnion supports and linked to the feed mechanism by a flexible chute.

Specifications
Calibre: 30 mm
Length of barrel: 70 calibres
Muzzle velocity: 1,040-1,220 m/s (HEI/APDS)
Traverse: 360° at 140°/s
Elevation: −13 to +85° at 80°/s
Rate of fire: 800 rds/min/barrel
Ammunition: 1.05 kg (TP, HEI, HEI-SD, API, APDS)
Mounting weight, with ammunition: 1,480 kg (SC)

Manufacturers/Contractors
Breda Meccanica Bresciana SpA, Brescia, Italy (prime).
DCN, Paris, France (licensee).

M2HB 12.7 mm (0.50 in) machine guns
Four M2HB 12.7 mm machine guns are carried and can be mounted on flexible mounts.

Specifications
Calibre: 12.7 mm (0.50 in)
Rate of fire: 450-550 rds/min
Muzzle velocity: 883 m/s (2,900 ft/s)
Max effective range:
anti-surface: 6,700 m (7,400 yd)
anti-air: 1,380 m (4,500 ft)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thomson-CSF ARBR-17
The Thomson-CSF ARBR-17 ESM suite is a high-performance radar detection, analysis and threat warning system, covering conventional radar threat frequencies (that is, C- to J-bands). The system analyses the measured radar parameters and uses these characteristics to determine other parameters such as the radar's type and identity. There are two antenna assemblies, the first being an omnidirectional system, installed on the ship's mainmast, which provides initial detection and threat frequency and carries out primary analysis. Below this are two eight-port directional antennas which provide more accurate bearing and frequency information. The antenna assemblies contain preamplifiers for improved performance.

Manufacturer/Contractor
Thomson-CSF, Arcueil Cedex, France.

DIBV-1A VAMPIR infra-red surveillance/surveillance and tracking systems
VAMPIR *(Veille Air-Mer Panoramique Infra-Rouge)* is a passive surveillance and search system for both sea and low-level air targets which is sited high on the ship's superstructure to ensure maximum range and freedom from obstruction.

The equipment is a bi-spectral device operating in two distinct IR bands, thus achieving a very low false alarm rate in the presence of environmental noise and enabling targets to be detected in a variety of weather conditions.

Specifications
(VAMPIR)
Wavelength: 4-5 and 8-13 μm (simultaneous channels)
Field-of-view: 360° × 0 to +24° elevation
Detection range: At least 10 km for frontal attack by missile or aircraft
Target designation accuracy: 1 mrad in elevation and bearing
Sensor cooling: Joule-Thomson cycle to about 80 K
Dimensions of stabilised unit: 125 × 60 cm diameter
Scanning head rotation rate: 60 rpm
Weight: 450 kg

Manufacturer/Contractor
CSEE Defence, Paris France.

ELECTRONIC COUNTERMEASURES (ECM)

ARBB 32 B/ARBB 36
ARBB 32B is a jammer introduced in the 1970s that is still installed in some of this class. It is being replaced by the ARBB 36.

Manufacturer/Contractor
Dassault Electronique, Saint Cloud, France.

DECOYS

DAGAIE countermeasures system

There are two DAGAIE launchers, which can be loaded with either IR or chaff rockets. The firing sequence runs automatically and is triggered on a missile alarm from a variety of sources, such as radar, ESM systems, or optical sights, thus providing a very short reaction time. The firing direction is optimised in accordance with the threat bearing, windspeed and direction, ship heading and speed data.

The launching of radar and IR decoys is so arranged that advanced mixed-guidance missile systems cannot discriminate between them and thus collocation of both decoys is achieved. The installation is a double mounting and comprises: (a) two trainable mountings carrying 10 replaceable containers (suitcases), each of which is loaded with either or I/J-band chaff projectiles.

A wide range of ammunition is provided by Etienne Lacroix Défense providing seduction, distraction and seduction/ dissimulation modes. The electromagnetic decoys are normally based upon aluminised glass fibre chaff with rapid bloom time and they cover the I and J frequency bands. The infra-red decoys cover both the 3-5 and the 8-14 μm bands.

Specifications

Traverse: 330° at 21°/s
Average reaction time: Within 4 s
REM rocket dimensions: 850 × 127 mm (33.5 × 5 in)
Rocket weight: 13 kg (28.66 lb)
Container dimensions: 900 × 130 mm (35.4 × 5.1 in)
Container weight: 20 kg (44.1 lb)
LIR/LEM container dimensions: 780 × 630 × 134 mm (30 × 24.8 × 5.3 in)
Container weight: 54 kg (119 lb)

Manufacturer/Contractor

CSEE Défense, Paris, France.

Dassault LAD offboard decoys

Dassault LAD *(Leurre Actif Décale)* is an offboard decoy system designed to counter radar-guided anti-ship missiles, consisting of an intelligent electronic decoy round, a standard 130 mm calibre multibarrelled launcher and a microprocessor-based fire-control unit. The system interfaces with the ship sensors to give fully automatic, semi-automatic or manual activation of the decoy round which consists of a low *g* rocket, a parachute, a transmitter, a receiver and antennas, control electronics and a battery source.

Specifications

Length: 900 mm (35.4 in)
Diameter: 127 mm (5 in)
Deployment time: >10 s
Jamming time: <3 min
Power consumption: 2 kW

Manufacturer/Contractor

Dassault Electronique, Saint-Cloud,.France.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

SENIT 4 tactical picture compilation and target designation system

SENIT *(Système d'Exploitation Navale des Informations Tactiques)* evolved from the early 1960s through French involvement in the American NTDS. SENIT 3 included an ASW element and when SENIT 4 entered service in December 1979 in the destroyer *Georges Leygues* it incorporated a French software language as well as French hardware. SENIT is designed to compile a tactical picture around major warships and task groups using onboard and offboard sensors. System architecture has changed radically since it entered service, with SENITs 1 to 3 all being mainframe systems, using CS-1 software language. The general purpose computers were designed to store tactical situation data and transmit the relevant data to the display systems and, through weapon control consoles, to weapons. In addition to running the display systems, the computers transmitted tactical situation data via communications links (Link 11 and Link 14) to other elements of the task group. The mainframe architecture was retained in SENIT 4 but uses the P2MS, a ruggedised derivative of the Compagnie Internationale pour l'Informatique (CII) Iris 35 M 16-bit mini-computer. This has a 256 k memory and originally used LTR 2 (a derivative of Pascal) and later LTR 3 software language. Peripherals which may be used include the control desk, a paper tape unit and magnetic disk drives. The system can monitor 120 tracks.

SENIT 4 uses the Vizir display subsystem, which has a 40 cm PPI screen which can display up to 130 tracks, 23 lines or vectors as well as 12 lines of 18 characters of alphanumeric data. The MCI includes programmed keyboard and rollerball. There are seven consoles and two Precilec E8000 automatic plotting tables in SENIT 4.

OPSMER command support system.

Manufacturer/Contractor

Thomson-CSF, Paris, France.

COMMUNICATIONS AND DATALINKS

Link 11
Link 14
Syracuse 1 Satcom

WEAPONS CONTROL

Gunfire control systems

There are two gunfire control systems in use:
DD 640-DD 643 Thomson-CSF Vega I (CTH)
DD 644-DD 646 Thomson-CSF CTMS

VEGA I (CTH) command and weapon control system

All ships are fitted with the Vega I command and weapon control system (also known as CTH *(Conduite de Tir Hybride)*), which uses separate search (DRBV 51) and fire-control (DRBC 32/33) radars to provide versatility and resistance to enemy ECM through the use of different frequency bands, with both radars featuring linear digital filtering for improved performance and reliability. DRBV-51 (Triton II) G-band radar is used for air/surface search, target designation and navigation, with a roll-stabilised antenna which includes a tunable magnetron transmitter with a peak power of 250 kW to provide a continuously variable transmission frequency over a wide band, together with two pulse lengths of 0.5 and 0.7 μs. DRBV 51 has an MTI filter channel for air search and a wide dynamic channel with clutter-suppression circuits for surface search and can detect a 2 m² air target at distances of 16 n miles (30 km) and altitudes of 6,000 m (2,000 ft) while 10 m² surface targets can be detected at 24.25 n miles (45 km).

Although Triton can be used for fire-control purposes this task is normally allocated to the I-band monopulse radars: DRBC 33 (Castor IIB) uses a conical scan system with a Cassegrain antenna and a TV tracker for use in severe jamming or very low-level attack conditions. This radar can acquire and lock on to a 2 m² target at 16 n miles (30 km) and 0.1 m² targets at 8 n miles (15 km). DRBC 32 incorporates linear digital MTI processing and the transmitter has a peak power of 30 kW to produce pulses of 4 μs in a 2.3° beam. Tracking accuracy is within 15 m, with an angular accuracy on a point target of 0.3 mrad.

The manufacturer claims that the system will detect surface targets at ranges of 28 to 32 km and low-level Mach 1 strike aircraft at 26 km in the most unfavourable cases. Against aircraft, the system's reaction time was 6 seconds in automatic mode and 12 seconds in semi-automatic mode. However, the track-while-scan capability was limited to two targets.

The stern of La Motte-Picquet *showing the machinery for streaming and recovering the DVBV-43 VDS in the raised position. Note also the antenna for the DRBN-32 (Racal-Decca 1226) radar (immediately to the right of the VDS 'fish') which is used for helicopter control* (H & L van Ginderen Collection)

Manufacturer/Contractor

Thomson-CSF, Paris, France.

DIBC-1A PIRANHA III infra-red tracker

The DIBC-1A PIRANHA III *(Pointeur Infra-Rouge pour l'Artillerie Navale)* augments the radar gunfire control system as part of the CTM *(Conduit de Tir Modulaire)* and the system was installed in the last three ships of the 'Georges Leygues' class destroyers. The PIRANHA system consists of an IR camera attached to the DRBC 33 radar director and there are two IR channels to enable simultaneous tracking in two wavelengths (4-5 and 8-12 μm). The receiver optical assembly, the analysis module, the IR detector, the cooling and the tracking electronics modules are in an externally mounted unit, with its own power supply.

The system has a 1° field of view and the control panel is below the deck in the CIC. The CTM interfaces with the SENIT or TAVITAC 2000/STI computers for firing designation and engagement monitoring.

Manufacturer/Contractor

SAT, Paris Cedex 13, France.

Sagem VIGY-105 optronic system

Two Sagem VIGY-105 optronic directors are being fitted in each ship during 1995-97. This three-axis stabilised director provides horizon-to-horizon surveillance against air and surface threats at medium range and designates them for the SADRAL system. The sensors are a high-resolution TV camera, an infra-red sensor and an eye-safe laser rangefinder.

Specifications

Mounting
Dimensions: 60 × 650 × 150 cm
Weight: 150 kg (approx)
Elevation: −25 to +65°
System harmonisation: <50 µrad

TV camera
Type: Si CCD monochrome CCIR (625 line)
Picture resolution: 768 × 575 pixels
Fields of view: 9 × 12°/3 × 4°

Laser rangefinder
Wavelength: 1.54 µm
Peak power: 20 MW
Output energy: 30 MJ
Pulse repetition rate: 20 Hz
Pulsewidth: 15 ns

Manufacturer/Contractor

SAGEM, Paris Cedex, France.

DLT L4/L5 torpedo fire-control system

The DLT *(Direction de Lancement de Torpilles)* torpedo fire-control system is installed in all ships of the class: DLT-L4C in D 640-643, and DLT-L5 in D 644-D 646. DLT-L4C consists of a torpedo launch control station in the combat information centre and interface boxes which provide the electrical supply and control links to the mechanical elements. The control console has a single display. Sonar data is received in the launch control station where it is processed. The most suitable tube or tubes are then selected and ballistic data is calculated before being transmitted to the weapon. The data provided includes gyro-deflection angle, time of trajectory and target depth. There are two launching modes; normal with automatic calculation of launch parameters and emergency in which manual calculation of displayed parameters is undertaken.

Manufacturer/Contractor

Thomson-CSF, Paris Cedex, France.

Latouche-Treville *(D 646) showing the sensor fit in the last three ships. On the bridge roof are a DRBC-33A fire-control director (for 100 mm gun) and a Racal-Decca RM 1226 navigation radar. The large dome at the foot of the mast is one of two for the French national Syracuse satellite system. The antenna on the platform halfway up the mast is DRBV 15A* (French Navy)

SONARS

DUBV 23D medium-frequency search sonar

DUBV 23D is a medium-frequency (5 kHz) panoramic sonar for anti-submarine operations which is operated in conjunction with the DUBV 43 VDS (see below). There is a 48-column transducer array housed in a streamlined bulb at the fore part of the ship. The panoramic sonar is intended for both search and attack roles and, in addition to the transducer array, the equipment includes the transmitter/receiver unit, a computer section for the processing of data being fed to weapons, and control and display consoles at the anti-submarine attack station. The DUBV 23D is of identical design to the towed sonar DUBV 43B/C and the two are used

RADARS

Type	DRBV 26D	DRBV 51C	DRBV 15A	DRBN 32 (Decca 1226) (two)	DRBC 32D	DRBC 33A (Castor II)
Ships	D 640-643	D 640-643	D 644-646	All	D 640-643	D 644-646
Role	Air search	Air search (low level and Exocet target designation	Air/surface search; target designation	One for navigation; one for close-range helicopter control	Vega fire-control system	Vega fire-control system
Band	D	G	E/F	I	I	I
Beam	2.5 × 8.3 csc² to 50°	—	csc² up to 50°	1.2°	1.5°	2.45 × 2.3°
Peak Power	2 MW	250 kW	n/a	25 kW	175 kW	30 kW
Gain	29 dB	—	30 dB	30 dB	37 dB	36 dB
Pulsewidth	2.5 µs	0.5/0.7 µs	n/a	0.05/0.25/1.0 µs	0.4 µs	0.4 µs
PRF	450 pps	varied	n/a	n/a	4,000-8,000 pps	4-800 pps
Scan rate	7/15 rpm	30 rpm	15/30 rpm	28 rpm	—	—
Typical range	150+ n miles on 10 m² target	16 n miles (30 km) on 2 m² target	P_d <50 per cent against 2 m² target at 60 n miles at heights up to 15,240 m (50,000 ft)	48 n miles		16 n miles (32 km) on 2 m² target
Manufacturers/ Contractors	Thomson-CSF, France	Thomson-CSF, France	Thomson-CSF, France	Racal Decca, UK	Thomson-CSF, France	Thomson-CSF, France

together for anti-submarine warfare. Operating modes provide for: panoramic surveillance, sector surveillance, step surveillance, passive surveillance at sonar frequency, panoramic attack transmission, or 'searchlight' attack transmission. In addition to the system's own display devices, the DUBV 23D provides for target data outputs to other ships' systems and repeater PPIs. The system is no longer in production, but systems in service will be upgraded through the SLASM programme.

Specifications

Transmitter

Frequencies: 4 operating frequencies in the neighbourhood of 5 kHz, of which 2 are operational
Power: 96 kW (2 × 48 kW)
Type: CW, FM (linear frequency modulation with non-coherent data processing at reception)
Duration: 4, 30, 150 or 700 ms
Scatter echo: With or without rejection
Doppler effect correction: On all 48 channels
Cadence: Adjustable step by step from 1,400-44,000 m (1,500-48,000 yd)
Receiver: Panoramic, directional, passive listening in sonar band

Manufacturer/Contractor

Thomson-CSF, Activités Sous-Marines, Sophia Antipolis Cedex, France.

DSBV 61A

The DSBV 61A is a very low-frequency, passive towed array sonar system consisting of a linear array, a towing cable which is also used for data transmission, a winch for handling and storage of array and cable, together with the necessary signal processing and data extraction electronics. The latter is made up of five cabinets plus two display consoles associated with two TOTES. The design allows two selectable towing modes: critical angle towing or towing behind the DUBV 43C VDS body. The display consoles feature three-colour display of target information and can display, on request, the various sonar memory pages. Operational on the F70 type ASW corvettes. DSBV 61A is fitted in D 640 to D 643 and DSBV 61B in D 644 onwards.

Manufacturer/Contractor

Thomson-CSF Activités Sous-Marines, Sophia Antipolis Cedex.

Thomson-CSF DUBV-43C variable depth sonar (VDS) aboard destroyer La Motte-Picquet *(D 645). The 'fish' can be towed at depths of 700 m (3,000 ft) and at speeds up to 24 knots. Note also the flight deck, hangar, WG 13 ASW helicopter and Crotale Naval EDIR SAM launcher on hangar roof* (Thomson-CSF)

DUBV 43B/C variable depth sonar system.

The DUBV 43B/C medium-frequency Variable Depth Sonar (VDS) comprises a streamlined towed body containing the sonar transducer array. This is towed from the stern of the parent vessel at speeds of up to 24 knots and can be set to run at depths down to 200 m (650 ft) in the 'B' version and up to 700 m (3,000 ft) in the 'C' version. It is equipped with stabilisers providing for control in roll, pitch and depth. The submerged weight of the fish is around 8 tonnes. Detection ranges of up to 25 km are quoted. Length of tow is 600 m (2,000 ft)

The DUBV 43B is in service in D 640 to D 642 and DUBV 43C in D 643-646. Two updates have been added to the system: UTCS 1B, which includes improvement of the signal processor, and a torpedo alarm receiver

Manufacturers/Contractors

DCN, Paris, France.
Thomson-CSF, Activités Sous-Marines, Sophia Antipolis Cedex, France.

AVIATION

AVIATION FACILITIES

Specifications

Flight deck: 20 × 14 m (67 × 45 ft)
Hangar: 16 × 12 m (52 × 40 ft)

HELICOPTERS

Two Westland WG.13 Lynx Mk 4 (FN). The ships' helicopters are dual roled, either for the ASW mission, carrying sonar or sonobuoy dispenser and ASW weapons, or in the anti-ship role, carrying AS 12 anti-ship missiles. 12 Honeywell 46 torpedoes are carried for use by the helicopters.

Specifications

Main rotor diameter: 12.80 m (42.00 ft)
Tail rotor diameter: 2.21 m (7.25 ft)
Length overall (rotors turning): 15.165 m (49.75 ft)
Width overall, main rotor blades folded: 2.94 m (9.65 ft)
Height overall, both rotors stopped: 3.48 m (11.42 ft)
Weights:
basic: 3,030 kg (6,680 lb)
operating, ASW role: 3,343 kg (7,370 lb)
reconnaissance (crew of 2): 3,277 kg (7,224 lb)
dunking sonar search and strike: 3,650 kg (8,047 lb)
take-off (max): 4,763 kg (10,500 lb)
Performance (max take-off weight, sea level, ISA)
cruising speed: 125 kts (232 km/h)
max endurance: 70 kts (130 km/h)
rate of climb: 661 m (2,170 ft)/min
hovering ceiling: 2,575 m (8,450 ft)
max range: 320 n miles (593 km)
max endurance: 2 h 50 min
Power plant: 2 Rolls-Royce Gem Mk 42-1 turboshafts, each with max contingency rating of 835 kW (1,120 shp)
Radar: Omera 31 search and tracking radar
Mission equipment: Alcatel DUAV 4 dipping sonar and Sextant Avionique MAD; Matra AF 530 or APX-334 stabilised sight
Weapons: ASW armament of two 46 homing torpedoes, one each on an external pylon on each side of fuselage, and six marine markers; or two depth charges. Four AS.12 or similar wire-guided missiles

PROPULSION

Specifications

System: combined diesel or gas turbine (CODOG)
Main machinery: 2 Rolls-Royce Olympus TM3B gas turbines; 34.5 MW (46,200 hp) sustained; 2 SEMT-Pielstick 16 PA6 V280 diesels; 9.41 MW (12,800 hp (m)) sustained
Shafts: 2
Propellers: cp

FURTHER INFORMATION

PROGRAMME

The 'Georges Leygues' (F 70) class was built to replace the twelve 'Surcouf' (T 47) and five 'Duperre' (T 53) class destroyers, which had been built in the 1950s and were due to reach the end of their useful lives in the early 1980s. It was originally planned to build these new ships in relatively large numbers, but financial constraints intervened and at one stage the ceiling was placed at six units, although the seventh was eventually reinstated. Thus, the first three were in the 1971-76 new construction programme, the fourth in 1978 estimates, the fifth in 1980 estimates, the sixth in 1981 estimates, and, finally, the seventh in 1983 estimates.

DESIGN

An essential ingredient of the original design was that one hull and propulsion system should serve for two different types of ship, an ASW ship and an anti-air ship, although in the event, the propulsion system differed (see following 'Cassard' class). The anti-submarine type — C 70 ASW — incorporated many of the features of the larger and more expensive 'Tourville' class (F 67).

Various changes were incorporated as the class was built. The first two ships have MM 38 Exocet, but from *Montcalm* (D 642) onwards they were fitted with MM 40 Exocet, instead. Experience at sea with the first ships of the class showed that the bridge was too low, so the last three (D 644 to D 646) had the bridge raised one deck level; they were also fitted with DSBV-1 towed array, and improved version of Crotale (Crotale EDIR), the 100 mm Compact mounting, later model sensors and other improvements.

MODERNISATION

The class as a whole is due to undergo a mid-life improvement programme from the late 1990s onwards. This will involve general refurbishment, updating equipment and bringing the first three ships up to the same standard as the last four. Among the new systems understood to be under consideration are:

- OTOBREDA/Matra ASW missile Milas.
- SLASM, which includes a new bow sonar and a VLF towed active sonar with separate passive array.
- To improve air defences against sea-skimming missiles Simbad twin SAM launchers are interchangeable with 20 mm guns.
- Two 30 mm guns and Sadral sextuple SAM launchers are being fitted to the four ships of the class.
- New ECM jammers and decoy launchers.
- Murene IR tracker is to be added to CTMS and possibly Vega systems.

Also to be installed is the *Operation d'Amélioration de le Autodéfense* (OP 3A) which integrates and co-ordinates existing air defence assets. OP 3A can detect an incoming anti-ship missile at 10 km and identify it at 5 km. *Jean de Vienne* (D 643) was fitted with OP 3A in 1996 and ran trials in the Mediterranean.

DEPLOYMENT

Primauguet and *Latouche-Treville* are allocated to GASM *(Groupe d'Action Sous-Marine)* at Brest. The remainder are assigned to FAN *(Force d'Action Navale)*, based at Toulon.

THE FUTURE

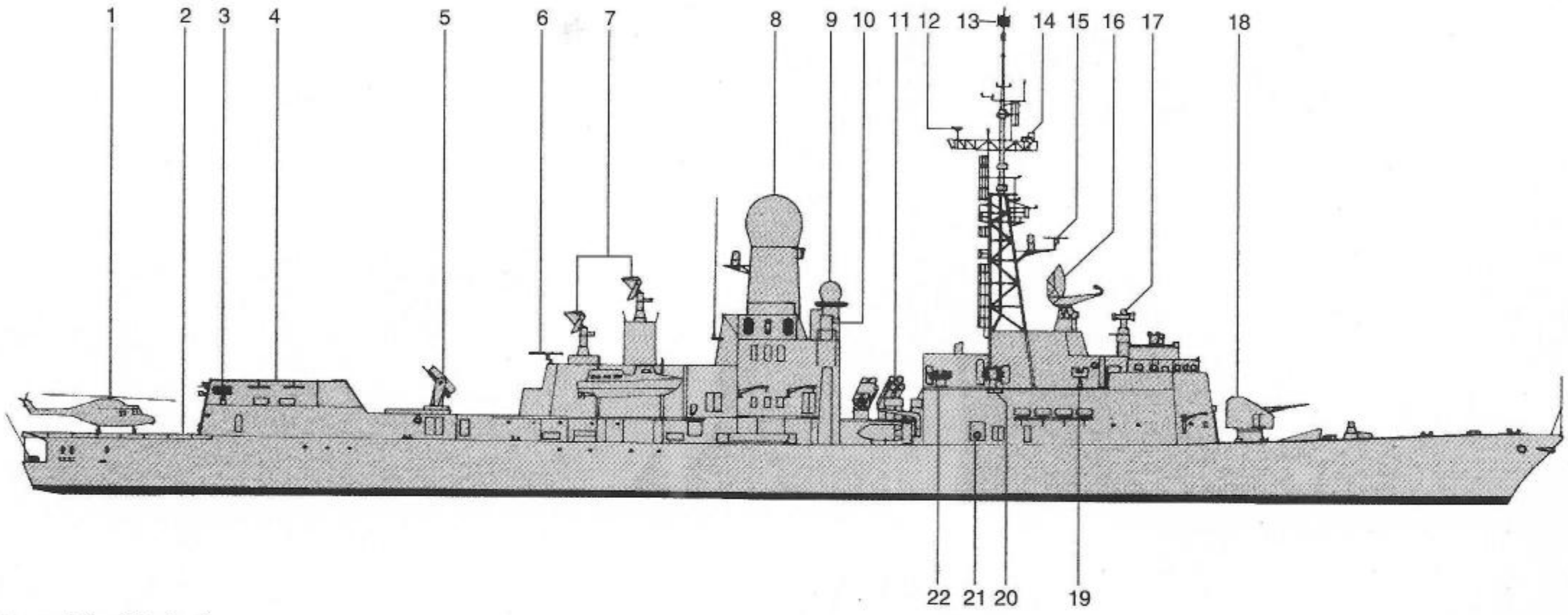
In mid-1996 the planned lives for these ships are:

Georges Leygues 2004
Dupleix, Montcalm 2006
Jean de Vienne 2008
Primauguet 2011
La Motte-Picquet 2012
Latouche-Treville 2014

However, the recent pressures on the French defence budget have resulted in major changes to such plans.

These pictures of Dupleix *(D-641) (left) and* Latouche-Treville *(D-646) show some of the differences between the first four and last three. In the last three the bridge was raised by one complete deck level and the DRBV-26 radar (the large elliptical array on the bridge roof in* Dupleix*) was deleted. Also MM 38 Exocet in the earlier ships was replaced by MM 40* (Dupleix — H & L van Ginderen Collection; Latouche-Treville — DCN/Biaugeaud)

CASSARD



Cassard (Ian Sturton)

1 *Westland WG13 ASW helicopter* **2** *Flight deck* **3** *Matra Sadral PDMS sextuple launcher* **4** *Hangar* **5** *Mk 13 Mod 5 launcher for Standard SM-1MR SAM* **6** *Racal-Decca DRBN-34A radar (helicopter control)* **7** *Raytheon SPG-51C fire-control director (for Standard SAM)* **8** *Thomson-CSF DRBJ-11B radar (air search)* **9** *Syracuse 1 Satcom* **10** *ARBB-33 jammer* **11** *Aerospatiale MM40 Exocet launcher (eight)* **12** *ARBR-17 radar warning* **13** *Saigon radio intercept* **14** *DIBV-1A VAMPIR* **15** *Racal-Decca DRBN-34A radar (navigation)* **16** *DRBV-26C radar (air/surface search)* **17** *Thomson-CSF DRBC-33A fire control (100 mm gun)* **18** *Modèle 68 100 mm (3.9 in)/55 CADAM automatic gun mounting* **19** *Oerlikon 20 mm cannon (two)* **20** *Sagaie 10-barrel decoy launcher* **21** *KD 59E fixed 533 mm (21 in) torpedo launcher* **22** *CSEE Défense Dagaie chaff launcher*

GENERAL SPECIFICATIONS

Operator: France
Type: Type F70 AA
National designation: Frégates anti-aériennes (FAA)

Class: CASSARD (Type F 70 AA)

Built: 2
Active: 2

Displacement:
standard: 4,230 t
full load: 4,700 t

Dimensions
Length: 139 m (455.9 ft)
Beam: 14 m (45.9 ft)
Draught: 6.5 m (21.3 ft) (sonar)

Speed: 29.5 kts
Range: 8,200 n miles at 17 kts; 4,800 n miles at 24 kts

Complement: 244 (22 officers) (accommodation for 251)

SHIPS

CASSARD (D 614)

Builder	Lorient Naval Dockyard, Lorient, France
Laid down	3 Sep 1982
Launched	6 Feb 1985
Commissioned	28 Jul 1988

JEAN BART (D 615)

Builder	Lorient Naval Dockyard, Lorient, France
Laid down	12 Mar 1986
Launched	19 Mar 1988
Commissioned	21 Sep 1991

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Exocet MM 40 anti-ship missiles

Both ships are armed with eight MM 40 Exocet anti-ship missiles, the launch canisters being mounted in two groups of four in the gap between the bridge structure and the main radar tower. The individual glass fibre launcher-containers are raised at an angle of +12° and point at an angle of some 60° from the centreline.

There are two versions of MM 40, designated Blocks 1 and 2. Block 2 missiles feature a new J-band (10 to 20 GHz) seeker with improved ECCM performance, associated electronics and a new guidance computer, although no further details are currently available. The new electronics permit the missile to optimise its sea-skimming height, allowing it to operate in conditions up to Sea State 7 even in severe ECM conditions. The fire-control system has also been adapted with the development of the Cat-Visac console which can operate with two types of the Exocet missile simultaneously. The new fire-control system allows improved target selectivity, attacks upon multiple targets by diverging and converging salvos.

Targets for the missiles are acquired by the ship's sensors, and the operator then aligns the axial gyros in the target's direction and begins the initiation sequence which can take up to 60 seconds. Exocet has a 105° off-axis engagement envelope and can perform one 15° change in the course of its flight. Once the missile has cleared the launcher-container, the sustainer carries it into the cruise phase and it then travels towards the general location of the target at a height of about 100 m (330 ft) which is low enough to reduce the chance of detection but adequate for target acquisition. Once the target is detected the missile descends to 9-15 m (30 to 50 ft) in the approach phase before descending to 8 m (26 ft) (2-5 m (7-16 ft) in a calm sea) for a sea-skimming terminal phase. A salvo may be fired in 12-20 seconds.

Specifications

	MM 40 Block 1	MM 40 Block 2
Length	5.78 m	5.80 m
Diameter	35 cm	35 cm
Wing span	1.13 m	1.13 m
Weight	855 kg	870 kg
Speed	Mach 0.9	Mach 0.9
Range	2-38 n miles (4-70 km)	2-40.5 n miles (4-75 km)
Warhead	165 kg HE frag	155 kg HE frag
Fuze	delay impact/ proximity	impact/proximity
Guidance	Inertial and active radar	

Manufacturers/Contractors

Aerospatiale Missiles, Paris Cedex, France (prime).
Luchaire Défense, Versailles Cedex, France (warhead).

SURFACE-TO-AIR-MISSILES (SAM)

Launchers taken from T 47 (DDG) ships. To be replaced by Aster 30 in due course.

Standard Missile-1 Medium Range (SM-1MR)

Main air defence weapon is the Standard SM-1MR surface-to-air missile, which is launched from a Mk 13 Mod 5 launcher (taken from the T 47 class DDGs) located immediately forward of the hangar, with a 40-round magazine directly underneath it. The Standard SM-1MR is the original version of the missile with a combined booster-sustainer rocket motor. The missile has a Raytheon conical scan, solid-state, semi-active radar seeker with scan receiver, speed gate and analogue guidance computer, and an expanding rod warhead in the ordnance section. The fire-control system uses two SPG-51C radars which are positioned facing the stern abaft the main radar tower.

Jean Bart *(D 615), one of two 'Cassard' class air defence destroyers* (DCN/Biaugeaud)

Specifications
(SM-1MR)
Length: 4.46 m (14.66 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.57 m (5.15 ft)
Weight: 1,343.6 kg (2,962 lb)
Speed: Mach 2.5
Range: 34.5 n miles (64 km)
Altitude: 24,400 m (80,000 ft)

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA.
Raytheon Missile Systems Division.

Matra SADRAL
Two six-tube launchers for Matra Sadral *(Système d'Auto Défense Raprochée Anti-aérienne Léger)* point-defence missile systems are located either side of the after end of the hangar. The missile is the IR-homing Mistral.

Specifications
Guidance: IR homing
Range: 2.2 n miles (4 km)
Warhead: 3 kg (1,500 tungsten balls)
Role: Anti-sea-skimmer, able to engage targets down to 3 m (10 ft) above sea level

Manufacturer/Contractor
Matra Défense, France.

TORPEDOES

There are two Modèle KD 59E fixed launchers for ECAN L5 ASW torpedoes, 10torpedoes are carried.

ECAN L5 Mod 4 533 mm (21 in) torpedoes
L5 is a heavyweight ASW torpedo which can be used for direct or indirect attacks. The weapon is of conventional design with a light alloy body, four fins and twin contrarotating propellers, and a blunt nose made of a laminated material. The torpedo is electrically propelled using silver-zinc batteries. They have passive/active seekers which have various operating modes including direct attack or programmed search.

Specifications
(Mod 4)
Length: 4.4 m (14.43 ft)
Diameter: 533.4 mm (21 in)
Weight: 935 kg (2,061 lb)
Speed: 35 kts
Range: 5 n miles (9.54 km)
Depth: 555 m (1,820 ft)
Warhead: 150 kg (331 lb)

Manufacturers/Contractors
DCN International (prime).
ECAN, Saint Tropez, France.

GUNS

100 mm/55 Modèle 1968
The single 100 mm/55 Modèle 1968-II CADAM dual-purpose gun is located on the foredeck ('A' position) and is normally operated in the fully automatic remote mode with an unmanned turret, although there is a fall-back manual mode, requiring two men in the turret. The turret is taken from an old ship and has been upgraded to CADAM *(CADence AMéliorée)* standard with improved recoil and feed systems, which raise the firing rate from 60 rds/min to 78 rds/min.

Specifications
Calibre: 100 mm
Length of barrel: 55 calibres
Muzzle velocity: 870 m/s
Traverse: 360° at 40°/s
Elevation: −15 to +80° at 25°/s
Mounting weight: 21 t
Crew: 2 (optional) and 2 loaders
Range:
anti-surface: 9.15 n miles (17 km)
anti-air: 8,000 m (26,000 ft)
Rate of fire: 78 rds/min
Ammunition: 13.5 kg (multipurpose projectile); 9.7 kg (charge)

Manufacturers/Contractors
Direction des Constructions Navales (DCN) (prime).
Mécanique Creusot-Loire, Marine Products (mountings).
DCN Ruelle (gun).
CSEE Défense (servo equipment).

Oerlikon 20 mm cannon
Two Oerlikon 20 mm cannon on Mk 2 mountings are located in single, manual mountings either side of the bridge structure.

Specifications
Calibre: 20 mm
Length of barrel: 70 calibres
Muzzle velocity: 835 m/s
Range:
anti-surface: 1.5 km
anti-air: 1,150 m (3,800 ft)
Rate of fire: 450 m/s
Round weight: 241 g
Projectile: 122 g
Elevation: −15 to +90°

M2HB 12.7 mm (0.50 in) machine guns
Four M2HB 12.7 mm machine guns are carried and can be mounted on flexible mounts.

Specifications
Calibre: 12.7 mm (0.50 in)
Rate of fire: 450-550 rds/min
Muzzle velocity: 883 m/s (2,900 ft/s)
Max effective range:
anti-surface: 6,700 m (7,400 yd)
anti-air: 1,380 m (4,500 ft)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Thomson-CSF ARBR-17
The Thomson-CSF ARBR-17 ESM suite is a high-performance radar detection, analysis and threat warning system covering conventional radar threat frequencies (that is, C- to J-bands). The system analyses the measured radar parameters and uses these characteristics to determine other parameters such as the radar's type and identity. There are two antenna assemblies, the first being an omnidirectional system installed on the ship's mainmast which provides initial detection and threat frequency, and carries out primary analysis. Below this are two eight-port directional antennas which provide more accurate bearing and frequency information. The antenna assemblies contain preamplifiers for improved performance.

ELECTRONIC COUNTERMEASURES (ECM)

ARBB 33

The ARBB 33 high-performance jammer is able to counter up to four threats simultaneously, including target designation radars as well as pulsed fire-control radars and seeker heads. There is a wide range of jamming modes: continuous noise, pulsed noise, cover pulse jamming, synchronous and asynchronous false echoes, and range gate pull off. The system can be alerted initially by a threat detection equipment, but also possesses an autonomous detection capability. It provides a 360° coverage in azimuth by means of electronically switched antennas for both detection and jamming in order to allow faster reaction time in any direction, the antennas being circular phased arrays for reception and transmission.

The system operates in H-, I- and J-bands and covers two 180° sectors; 36 10° lobes on each side give complete coverage and direction within 5°. Output power is more than 100 kW.

Specifications

Frequency: H-, I- and J-bands
Azimuth coverage: 2 sectors of 180°
Reaction time: <0.5 s
Detection sensitivity: Better than −50 dBm
Bearing accuracy: Better than 5° RMS
Dimensions:
canisters: 1.2 × 2.2 m
cabinet: 1.8 × 0.6 × 0.78 m
Weights:
canisters: 500 kg
cabinet: 400 kg

Manufacturer/Contractor

Dassault Electronique, Saint-Cloud, France.

DECOYS

DAGAIE countermeasures system

There are two DAGAIE launchers at the after end of the bridge structure which can be loaded with either IR or chaff rockets. The firing sequence runs automatically and is triggered on a missile alarm from a variety of sources, such as radar, ESM systems, or optical sights, thus providing a very short reaction time. The firing direction is optimised in accordance with the threat bearing, windspeed and direction, ship heading and speed data.

The launching of radar and IR decoys is so arranged that advanced mixed-guidance missile systems cannot discriminate between and thus collocation of both decoys is achieved. The installation is a double mounting and comprises: (a) two trainable mountings carrying 10 replaceable containers (suitcases), each of which is loaded with either IR or I/J-band chaff projectiles.

A wide range of ammunition is provided by Etienne Lacroix Défense providing seduction, distraction and seduction/ dissimulation modes. The electromagnetic decoys are normally based upon aluminised glass fibre chaff with rapid bloom time and they cover the I and J frequency bands. The infra-red decoys cover both the 3-5 and the 8-14 μm bands.

Specifications

Traverse: 330° at 21°/s
Average reaction time: Within 4 s
REM rocket dimensions: 850 × 127 mm (33.5 × 5 in)
Rocket weight: 13 kg (28.66 lb)
Container dimensions: 900 × 130 mm (35.4 × 5.1 in)
Container weight: 20 kg (44.1 lb)
LIR/LEM container dimensions: 780 × 630 × 134 mm (30 × 24.8 × 5.3 in)
Container weight: 54 kg (119 lb)

Manufacturer/Contractor

CSEE Défense, Paris, France.

CSEE Sagaie

Two CSEE Sagaie 10-barrelled trainable decoy launchers are located on the bridge wings beside the after leg of the mast. SAGAIE *(Système d'Autodéfense pour la Guerre Infra-rouge et Electromagnetique)* is a fully automatic, passive countermeasures system providing protection against incoming missiles guided by electromagnetic (EM) or infra-red (IR) seekers, or any combination of these two, even when the missiles are attacking simultaneously over the entire horizon. SAGAIE is fully automatic from the reception of a missile threat alarm originating from any of the surveillance systems (radar, IR, optical or ESM) and optimises the use of decoys in a very short reaction time. The equipment can be used alone (confusion and distraction) or jointly with a jammer (dilution, substitution after concealment, substitution after deception) by firing substitution decoys. The two fully stabilised launchers are loaded with 10 rockets in 30 kg containers and trainable in azimuth and elevation; two servo units; two aiming and maintenance units; and a processing unit which computes the rocket launching sequence and provides information for the supervision unit; a supervision unit with controls and status displays; and an interface unit which provides for operation with any tactical data or target designation system. SAGAIE fires either EM or IR decoy rocket-type ammunition or both.

Specifications

Range:
chaff: 4.3 n miles (8 km)
IR flares: 1.6 n miles (3 km)

Manufacturer/Contractor

CS Défense, Courtaboeuf, France.

Dassault LAD offboard decoys

Dassault LAD *(Leurre Actif Décale)* is an offboard decoy system designed to counter radar-guided anti-ship missiles, consisting of an intelligent electronic decoy round, a standard 130 mm calibre multibarrelled launcher and a microprocessor-based fire-control unit. The system interfaces with the ship sensors to give fully automatic, semi-automatic or manual activation of the decoy round, which consists of a low *g* rocket, a parachute, a transmitter, a receiver and antennas, control electronics and a battery source.

Specifications

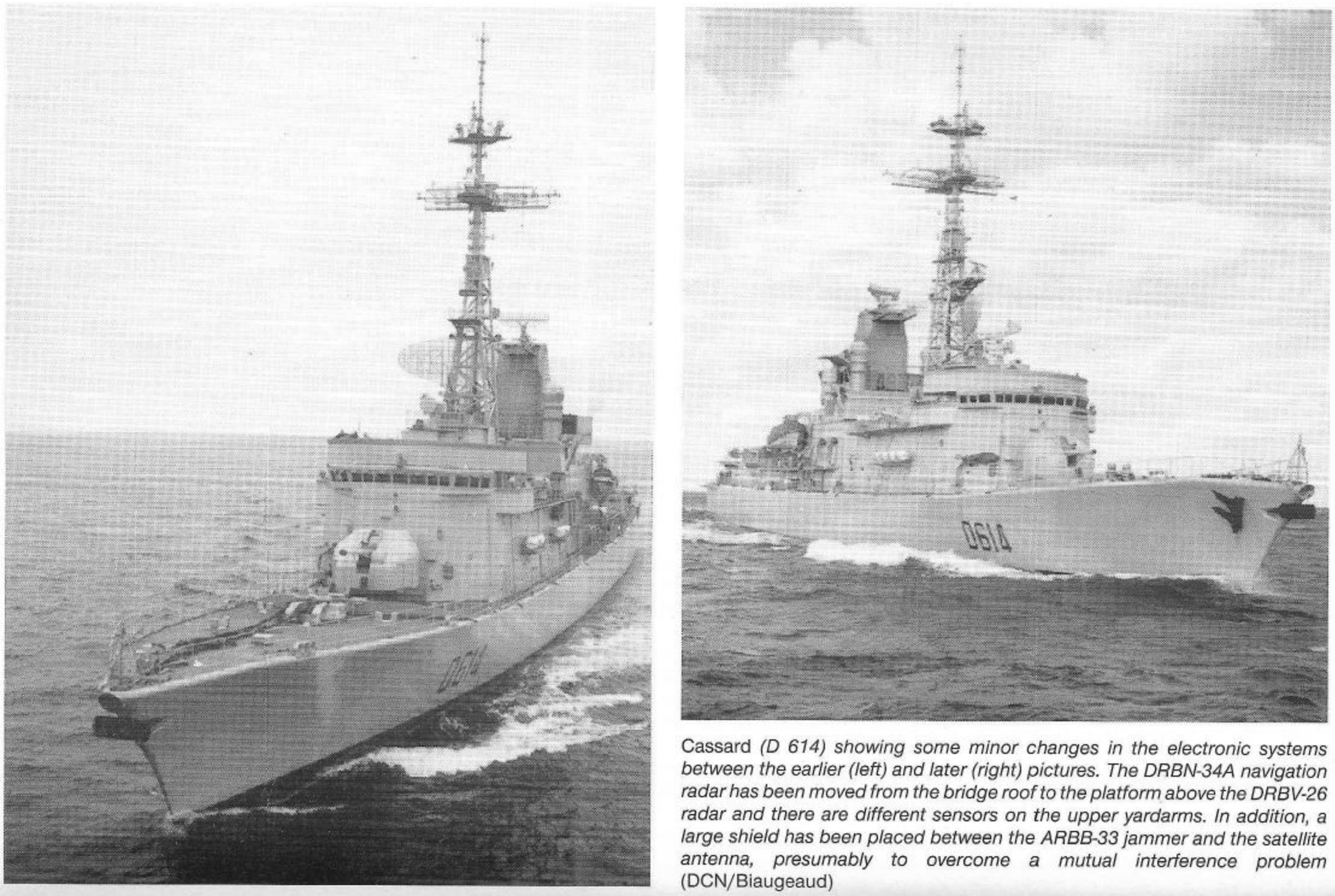
Length: 900 mm (35.4 in)
Diameter: 127 mm (5 in)
Deployment time: >10 s
Jamming time: <3 min
Power consumption: 2 kW

Manufacturer/Contractor

Dassault Electronique, Saint-Cloud, France.

AN/SLQ-25 Nixie noisemaker

One AN/SLQ-25 Nixie (Phase 1), solid-state, modular design electroacoustic countermeasures decoy system is used to protect the ship from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or



Cassard *(D 614) showing some minor changes in the electronic systems between the earlier (left) and later (right) pictures. The DRBN-34A navigation radar has been moved from the bridge roof to the platform above the DRBV-26 radar and there are different sensors on the upper yardarms. In addition, a large shield has been placed between the ARBB-33 jammer and the satellite antenna, presumably to overcome a mutual interference problem* (DCN/Biaugeaud)

load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 488 m (1,600 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 95 cm long (3.16 ft), 15.24 cm (6 in) in diameter and weigh 18 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body at a time is deployed.

Manufacturer/Contractor
Aerojet ElectroSystems, Sacramento, California, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

DIBV-1A VAMPIR infra-red surveillance/ surveillance and tracking systems
VAMPIR *(Veille Air-Mer Panoramique Infra-Rouge)* is a passive surveillance and search system, for both sea and low-level air targets, which is integrated with the search radar for active/passive tracking in all weathers. The equipment is a bi-spectral device operating in two distinct IR bands, thus achieving a very low false alarm rate in the presence of environmental noise and enabling targets to be detected in a variety of weather conditions.

Specifications
(VAMPIR)
Wavelength: 4-5 and 8-13 µm (simultaneous channels)
Field of view: 360° × 0 to +24° elevation
Detection range: At least 10 km for frontal attack by missile or aircraft
Target designation accuracy: 1 mrad in elevation and bearing
Sensor cooling: Joule-Thompson cycle to about 80 K
Dimensions of stabilised unit: 125 × 60 cm diameter
Scanning head rotation rate: 60 rpm
Weight: 450 kg

Saigon
Saigon is a radio intercept system; the antenna is at the masthead.

SENIT 6 tactical data/target designation system
SENIT 6 *(Système d'Exploitation Navale des Informations Tactiques)* was designed for the F 70 AA air defence destroyers and entered service with the commissioning of the *Cassard* in July 1988. It was the first of the French SENIT systems to use a federated architecture, with seven CIMSA Sintra 15 M/125X 32-bit mini-computers, with an eighth to be added when Link 16 is implemented. These computers have a modular memory of between 64 k and 512 k words in 64 k word sections, and an operating speed of 1 Mips. One computer is kept in reserve while the others are responsible for specific functions: search, electronic warfare/links, anti-ship engagements/ship defence, displays, and the area air defence missile system. They are linked through a Dassault Electronique Bus Standard Marine (also known as Digibus), a local area network capable of 1 Mbyte/s. The software language is LTR 2, and the system has between 1.5 and 2 million lines of code. SENIT 6 can monitor 250 tracks simultaneously.

Each display can present up to 70 tracks and 96 symbols together with a marker and a close control symbol as well as alphanumeric data. The GVM display used in SENIT 6 has a 40 cm monochrome display with interchangeable and fixed function keys and a rollerball, while other 48.25 cm (19 in) displays are used for presenting alphanumeric data. There are 11 one-man consoles and a two-man console for the commanding officer and the tactical action officer. The display systems are supplemented by two E8000 plotting tables, each of which can display up to 20 tracks and can provide up to 30 historical tracks.

Manufacturer/Contractor
DCNI/ISC.

RADARS

Type	DRBJ 11B	DRBV 26C	DRBN 34A (Decca 1229) (two)	DRBC 33A	AN/SPG-51C
Role	3D Air search	Air/surface search	Set 1: navigation; Set 2: close-range helicopter control	Fire control 100 mm gun	Fire control (Standard SAM)
Band	D/E	D	I	I	G/I
Beam	—	2.5 × 8.3 csc² to 50°	1.2°	2.45 × 2.3°	Track: 1.6° Illum: 0.9°
Peak Power	—	2 MW	25 kW	30 kW	Track: 81 kW Illum: 5 kW
Gain	—	29 dB	30 dB	36 dB	Track: 39.5 dB Illum: 45 dB
Pulsewidth	—	2.5 µs	0.05/0.25/1.0 µs	0.5 µs	Track: 2.1-3.2 µs
PRF	—	450 pps	n/a	4-800 pps	Surface: 4.1 kHz Air: 9.5-16.7 kHz
Scan rate	15 rpm	7/15 rpm	28 rpm	—	—
Typical range	200 n miles (366 km)	150+ n miles on 10 m² target	48 n miles	—	—
Manufacturers/ Contractors	Thomson-CSF, France	Thomson-CSF, France	Racal Decca, UK	Thomson-CSF, France	Raytheon

COMMUNICATIONS AND DATALINKS

Link 11
Link 14
Link 16 (to follow)
Syracuse 1 Satcom

WEAPONS CONTROL

DCN CTMS optronic/radar system with DIBC 1A PIRANHA II IR/TV tracker
CSEE Najir optronic secondary director.

SONARS

Thomson Sintra DUBA 25A (D 614) or DUBV 24C (D 615); hull-mounted; active search and attack; medium frequency. Both may be fitted later with DSBV 62C passive towed array; very low frequency.

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 16 × 14 m (52 × 45 ft)
Hangar: The hangar accommodates one helicopter
Landing aid: Samahe 210 helicopter handling system

HELICOPTERS

Eurocopter AS 565MA Panther
One Eurocopter AS 565MA Panther light liaison, search and rescue helicopter.

Specifications
Rotor diameter: 13.29 m (43.6 ft)
Fuselage length: 11.41 m (37.43 ft)
Height to rotor head: 4.0 m (13.12 ft)
Weights
empty: 2,262 kg (4,987 lb)
take-off: 4,250 kg (9,370 lb)
Performance
max speed (never-exceed): 160 kts (296 km/h)
cruising speed (sea level): 148 kts (274 km/h)
rate of climb (sea level): 420 m (1,380 ft)/min
hovering ceiling (in ground effect): 2,600 m (8,530 ft)
Engines: 2 Turbomeca Ariel 1M1 turboshafts; take-off, 558 kW (749 shp); continuous, 487 kW (653 shp)
Accommodation: 2-man crew; cabin can hold 10 passengers

PROPULSION

Specifications
System: Diesel
Main machinery: 4 SEMT-Pielstick 18 PA6 V 280 BTC diesels; 31.75 MW (43,200 hp (m)) sustained
Shafts: 2

FURTHER INFORMATION

PROGRAMME

These two ships were built on the same hull as the 'Georges Leygues' F 70 (A/S) class, but with very different armament and propulsion systems. They were intended to replace the four anti-aircraft destroyers of the 'Du Chayla' (modified T 47) class. In fact, they were given the Mk 13 twin-arm launchers, magazines, SPG-51C directors and Standard SM-1MR missiles from the first two of that class, which were decommissioned early to make the systems available.

Funds for the first ship were allotted in 1978 estimates and for the second in the 1979 estimates. Funds were also allotted for a further two ships in the 1983 estimates and an order was actually placed on 27 February 1984, but was later cancelled. One of the major reasons for this cancellation was that the US Navy ended production of the Standard SM-1MR missile in favour of the SM-2.

The building programme of the two ships was considerably slowed down by finance problems and doubts about the increasingly obsolescent Standard SM 1 missile system.

They were originally rated as C 70 'corvette anti-aérienne' but this was changed to F 70 AA (frégate anti-aérienne) on 6 June 1988.

The DRBJ 11B radar was not ready at the time *Cassard* was completed, so DRBV 15 was fitted as a temporary measure. The definitive DRBJ 11B radar was later fitted in 1992.

DESIGN

The original intention was for the F 70 ASW and F 70 AA to have the same hulls and CODAG propulsion systems. The gas turbines would, however, have required large air intake and exhaust uptake trunking, and the hot exhaust gases would have made it difficult, if not impossible, to site the radar tower, with its DRBJ-11B radar, amidships. It was therefore decided to install an all-diesel propulsion system, although these are the same SEMT-Pielstick units as in the 'Georges Leygues' class.

It was also intended to site a second 100 mm gun aft, but this was dropped when it was decided to install a flight deck and hangar for a helicopter which, because of the Standard launcher and magazine, are sited further aft than in the 'Georges Leygues' class. The Lynx Mk 4 (FN) was originally operated from these ships, but has now been replaced by the Panther.

MODERNISATION

Under current plans it is intended that the mid-life refit will include replacing the SM-1MR by the new Aster 30, although whether this proposal will survive the current stringent economies remains to be seen.

However, it should be noted that displacement is creeping up — it is now in excess of 4,700 tonnes.

OPERATIONAL

Helicopter used for third party targeting for the SSM.

DEPLOYMENT

Both ships are assigned to Force d'Action Navale (FAN) and are based at Toulon.

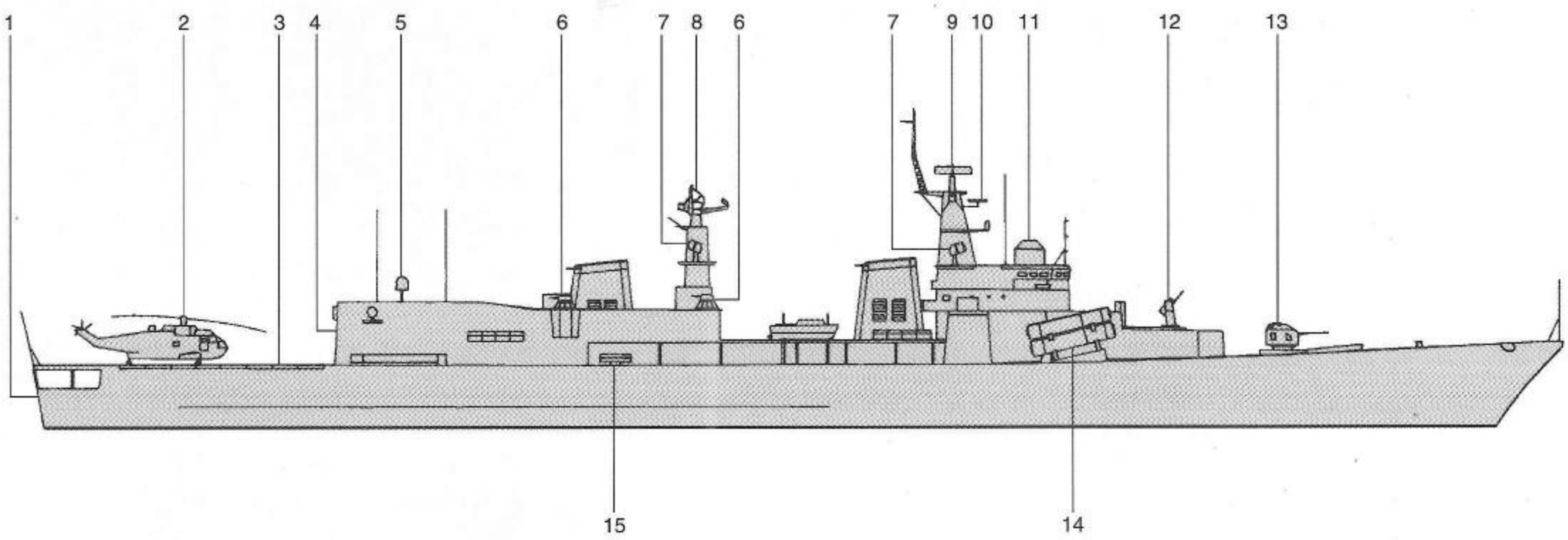
THE FUTURE

According to current plans, the service lives of these two ships will end:

Cassard — 2013
Jean Bart — 2015.

Cassard *(D 614). There is a Standard SM-1 MR missile on the launcher and above it are the two Raytheon SPG-51C radar directors for the air defence system. Note that the DRBV-15 is installed atop the tower without a radome, as the DRBJ-11B was not ready for service use at this time. On the right side of the tower is a Syracuse 1 satellite antenna (small dome) and below that an ARBB-33 jammer. A Sadral short-range missile launcher is on the starboard side of the hangar* (DCN/Biaugeaud)

DELHI



Delhi (Ian Sturton)
1 *VDS (type not yet known)* **2** *Westland Sea King Mk 42B (two)* **3** *Flight deck* **4** *Hangar* **5** *Satcom* **6** *Russian 30 mm/65 Gatling CIWS* **7** *Bass Tilt fire control (for 30 mm CIWS)* **8** *Bharat/Signaal RALW (LW-08) radar (air search)* **9** *Indra radar (surface search)* **10** *Navigation radar* **11** *Band Stand datalink* **12** *SA-N-7 launcher* **13** *Russian 100 mm (3.9 in)/59 single gun mounting* **14** *Russian SS-N-22 Sunburn (four launchers)* **15** *Whitehead B-515 324 mm triple torpedo launcher (two sets) (Armament subject to confirmation)*

GENERAL SPECIFICATIONS

Operator: India
Type: Project 15

Class: DELHI

Building: 4
Active: 0

Displacement:
full load: 6,200 t

Dimensions
Length: 160 m (524.9 ft)
Beam: 17 m (55.8 ft)
Draught: 6.5 m (21.3 t)

Speed: 28 kts

Complement: 350

SHIPS

DELHI
Builder Mazagon Dock Ltd, Bombay, India
Laid down 14 Nov 1987
Launched 1 Feb 1991
Commissioned 1997

MYSORE
Builder Mazagon Dock Ltd, Bombay, India
Laid down 2 Feb 1991
Launched 4 Jun 1993
Commissioned 1997

BANGALORE
Builder Mazagon Dock Ltd, Bombay, India
Laid down 14 Dec 1992
Launched 20 Mar 1995
Commissioned 1999

BOMBAY (to be confirmed)
Builder Mazagon Dock Ltd, Bombay, India
Laid down 1996
Launched 1998
Commissioned 2002

WEAPONS SYSTEMS*

SURFACE-TO-SURFACE MISSILES (SSM)

P-270 Moskit (NATO = SS-N-22 'SUNBURN') medium-range anti-ship missiles

There are four SS-N-22 launcher-containers, situated either side of the bridge. This ramjet-powered Mach 2 missile system is designed to reach the target so fast that the enemy, even if using Aegis-equipped ships with SM-2 missiles, will have insufficient time in which to react. The missile has four clipped-delta wings and four smaller tail surfaces of similar shape, all of which are folded when the missile is in the launcher.

Sketches and most pictures released to date indicate the *Delhi* will be armed with four SS-N-22, sited in two pairs either side of the bridge. However, a total of four missiles (there are no reload facilities) seems small for such a large ship and an ahead view of the first of class in dry dock suggests that there is space for four launchers on either side, for a total of eight, which would be similar to the installation in the 'Sovremenny' class destroyers of the Russian Navy. Whether there are two or four launchers on each side, the tubes will be inclined at an angle of 15°.

It appears that the fire-control system will be based on the 'Band Stand' D/F-band (1-4 GHz) radar/datalink which also has a tracking function for anti-ship missiles. In the Russian Navy, the fire-control system can also receive data from the Big Bulge I/J-band radars carried by Ka-25 'Hormone B'/Ka-27 'Helix B' helicopters (for example, in 'Sovremenny' class) for Over-The-Horizon (OTH) targeting and it seems probable that the helicopters aboard the *Delhi* (Sea King or Hindustan ALH) will have a similar capability.

An engagement will start with data on the location of both launcher and target being fed into the missile from the fire-control system. The missile may be launched to engage targets in a 120° arc based upon the ship's course and, once clear of the launcher, wings and tail surfaces deploy and the missile briefly rises, before dropping to its cruising altitude of 20 m, by which time the ramjet is operating. The active radar seeker then searches for the target and homes in on it when 'lock on' is achieved. In the event of jamming, the seeker has a home-on-jam capability.

At a speed of Mach 2, the missile takes 2 minutes to cover its full range and the manufacturers claim that 1 to 2 missiles could incapacitate a destroyer, while 1-5 missiles could sink a 20,000 tonne merchantman. An extended range missile (3M80E) is now available with a range of 65 n miles (120 km) although whether this is being supplied to India is not known.

Specifications
Length: 9.38 m (30.8 ft)
Diameter: 1.30 m (4.26 ft)
Wing span: n/k
Weight: 3,950 kg (8,710 lb)
Speed: Mach 2
Range:
3M80 missile: 48 n miles (90 km)
3M80E missile: 65 n miles (120 km)
Guidance: Inertial
Warhead: 300 kg (660 lb) semi-armour-piercing

Manufacturer/Contractor
Raduga, Russia.

SURFACE-TO-AIR MISSILES (SAM)

M-22 Uragan (NATO = SA-N-7 'Gadfly') local area defence system

The 'Delhi' class is fitted with a single M-22 Uragan launcher on the foredeck, with a magazine beneath it. The Russian M-22 Uragan (naval version of the Russian Army's SA-11 'Gadfly') is a modular local area air defence system designed for employment in warships of 1,500 tonnes displacement or more and equipped with a 3D radar system, and has been designed for multi-target engagements. The system is capable of operating autonomously or may be linked either to a tactical

* These details of weapons systems are based on current estimates and are subject to change. One possibility is that SS-N-2 may be installed instead of the more advanced SS-N-22

data handling system or to a command and weapon control system.

The system consists of the 9M38M1 Smerch (NATO = SA-N-7 'Gadfly') missile, a launcher-handling system and a computer-based radar fire-control system which, in some installations, is complemented by a TV sight. The missile has a solid propellant booster-sustainer, employs semi-active radar homing and is capable of manoeuvres up to 23 *g*.

The handling-launching system is based upon a magazine containing between two and eight 12-cell drum magazines, giving a total number of missiles between 24 and a maximum of 96. The launcher is a single-rail unit which closely resembles the US GMLS Mk 13 and can be reloaded in 12 seconds.

According to the manufacturer's literature the system is capable of engaging aircraft and missiles travelling at up to 830 m/s (Mach 2.5), although subsonic missiles travelling at 330 m/s may also be engaged. Crossing target aircraft may be engaged at distances up to 10 n miles (18 km) while missiles may be engaged at ranges up to 3.25 n miles (6 km). The double-round kill probability against aircraft ranges from P_k = 0.81 to 0.96, and against missiles is P_k = 0.43 to 0.86. Reaction time is 16-19 seconds when the ship is on alert or 3 minutes from a 'cold' start.

The rate of fire depends upon the number of channels ranging from one missile every 12 seconds with two channels of fire to one every 3 seconds with 12 channels. A Sovremenny-type system with six channels of fire can launch a missile every 6 seconds.

Specifications
Uragan
Length: 5.55 m (18.2 ft)
Diameter: 40 cm (15.75 in)
Wing span: 86 cm (33.85 in)
Weight: 690 kg (1,521 lb)
Speed: Mach 2.5
Range: 1.5-16 n miles (3-30 km)
Altitude: 30-22,000 m
Guidance: Inertial and semi-active radar
Warhead: 70 kg HE (154 lb)

TORPEDOES

Whitehead B515 anti-submarine torpedo launching system
There are two B-515 triple 324 mm diameter torpedo launchers mounted on the open deck, with one installation on each side of the ship abreast the after stack. The tubes are manually loaded and trained but remotely operated from the combat information centre, although emergency local operation is possible.

Specifications
Length: 3.4 m (11.15 ft)
Height: 1.2 m (3.94 ft)
Width: 1.285 m (4.22 ft)
Weight: 1,050 kg (2,315 lb) (unloaded)

Manufacturer/Contractor
Whitehead, Division of Gilardini SpA, Salviano, Italy.

Whitehead A244/S lightweight anti-submarine torpedo
The 'Delhi' class ships will use the Whitehead A244/S. The seeker in the A244/S is the Alenia CIACIO-S which is capable of active, passive or mixed modes for closing on to its target and can discriminate between decoys and real targets in the presence of heavy reverberations by specially emitted pulses and signal processing. It also discriminates between target noise and reverberations, as well as having a preset series of programmable search patterns and tactical manoeuvres (including re-attack procedures). The seeker has a large search volume covered by multiple preformed beams following a number of self-adaptive search patterns and is reported capable of target detection at −5 dB in good acoustic conditions. The computerised homing system also provides for presettable combinations of signal processing, spatial filtering and tactical torpedo manoeuvring. The software may be reprogrammed by the customer to meet new tactical conditions. Upon launching the A244/S initially steers a straight course and, if the target is not detected, it then begins a search pattern which may be either a spiral between preselected depths or a helix pattern.

Specifications
Length: 2.7 m (8.86 ft)
Diameter: 324 mm (12.75 in)
Weight: 215 kg (474 lb)
Warhead: 34 kg (80 lb) shaped charge HBX-3 HE
Propulsion: Electric; silver-zinc batteries
Range: 3.5 n miles (6 km)
Speed: 30 kts
Guidance: Active/passive sonar, self-adaptive programmed patterns

Manufacturer/Contractor
Whitehead SpA, Salviano, Italy.

GUNS

AK-100 100 mm/59 medium calibre dual-purpose gun
One AK-100 100 mm (3.9 in)/59 calibre water-cooled gun is mounted in an enclosed turret on the foredeck ('A' position).

Specifications
Calibre: 100 mm (3.9 in)
Length of barrel: 59 calibres
Muzzle velocity: 880 m/s (2,887 ft/s)
Traverse: 200° at 30°/s
Elevation: −10 to +85° at 20°/s
Weight of projectile: 15.6 kg (34.4 lb)
Rate of fire: 60 rds/min
Range, anti-surface: 21.5 km

30 mm AK-630 close in weapon system
There are four AK-630 close in weapon system (CIWS) turrets which, instead of being split fore and aft as is the case in most Russian surface warships, are grouped in two close pairs either side of the after stack and mainmast. This multibarrel, high volume-of-fire gun system, has a separate fire-control radar and a below-deck control station with remote optical and/or electro-optical sensor. It fires five types of fire mission: against anti-ship missiles, aircraft, small surface vessels, drifting mines, and unprotected shore targets. The weapon consists of six water-cooled barrels, using the Gatling-principle with a fixed breech block and revolving barrels. The magazine contains 2,000 rounds of HE-I and HE-T ammunition. The gun fires bursts of up to 400 rounds, during which both the barrel and the breech block are cooled, with used cartridges and links being ejected into a bin below the elevating mass. The mounting is unusual in having an ignition system for burning off gun gases accumulating within it during firing.

Specifications
Calibre: 30 mm
Length of barrel: 65 calibres
Muzzle velocity: 890 m/s (2,920 ft/s)
Traverse: 360° (depending on location of turret) at 70°/s
Elevation: −12 to +88° at 50°/s
Crew: 1 (off mount)
Range:
radar fire control: 4,000 m (13,000 ft)
electro-optic fire control: 5,000 m (16,400 ft)
Rate of fire: 4,000-5,000 rds/min
Ammunition:
round: 1.224 kg (2.7 lb)
projectile weight: UOF-84 384 g (13.5 oz); UOR-84 388 g (13.7 oz)

DEPTH CHARGES

There are two depth charge rails.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Ajanta
The Ajanta radar intercept suite is the first such Indian set to reach operational status. It is believed to be based on the Selenia (now Alenia) INS-3, but appears to have a much larger threat library.

Manufacturer/Contractor
Bharat Electronics Ltd (BEL), Bangalore, India.

ELECTRONIC COUNTERMEASURES (ECM)

Elettronica TQN-2
TQN-2 is an active jammer, normally found as part of the Italian INS-5 system. It performs smart jamming and deception over the band in which the most dangerous anti-ship weapons are operating (H- to J-bands), and provides automatic jammer programming and quick data exchange with the CIC and the chaff launcher system. The TQN-2 is built from a modular suite which can be expanded from a noise/deception jammer with a single antenna and transmitter to more complex configurations to achieve the most effective methods required.

Manufacturer/Contractor
Elettronica SpA, Rome, Italy.

DECOYS

Four 16-barrel chaff launchers triggered by the Ajanta system.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Shikari command and weapon control system
India is developing its own naval fire-control and command/weapon control systems, the first such system being the Bharat Vympal which entered service when the 'Khukri' class corvette *Kuthar* was commissioned in June 1990. A more advanced system, Shikari, is being installed in the 'Delhi' class destroyers. This has a distributed architecture and is based upon purpose-built workstations using Barco 48 cm (19 in) raster scan displays and alphanumeric display (possibly based upon liquid crystal technology), with an 38I based upon QWERTY keyboard, numeric pad and probably rollerball. A frigate will have three such workstations, probably supplemented by a data processing unit linked by a United Defence Unicom-type local area network capable of 10-20 Mb/s. Fire-control interfaces appear to use the weapon control modules of the Seaguard system and the TMX/Ka-CW tracker radars are also reportedly part of the system for use with the domestically produced Trushul surface-to-air missile.

Manufacturer/Contractor
Bharat Electronics Ltd (BEL), Bangalore, India.

RADARS

Bharat/Signaal RALW (LW 08)
RALW is a licence-produced version of HSA's LW-08 air search radar.

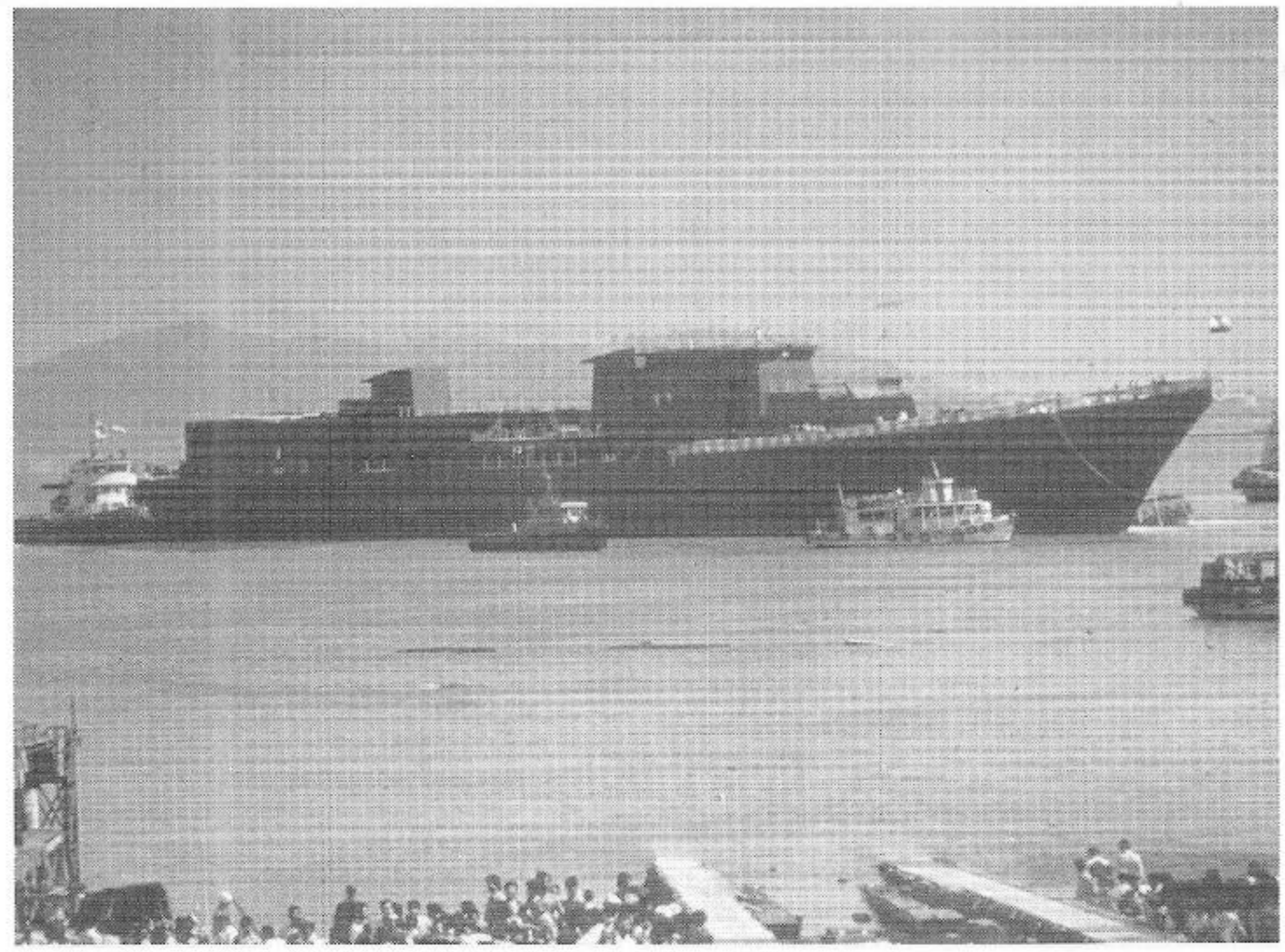
Specifications
Band: D
Range: 145 n miles for 2 m² target at 85,000 ft
Beam: 2.2 × csc² to 40°
Peak power: 150 kW
Gain: 30 dB
Pulsewidth: 35/69 µs
PRF: 1,000/500 pps
Scan rate: 7.5/15 rpm

Manufacturer/Contracter
Bharat Electronics Ltd (BEL), Bangalore, India.

Indra
Indra is a Bharat-produced surface search radar, probably associated with the Indra series of low-level air defence radars being developed for the Indian Army and Air Force.

Band Stand air and surface surveillance radar
Band Stand is the name given by NATO to the Russian D/E/F-band radar identified by its large dome-shaped radome, and considered to be associated with the ship's overall air surveillance requirements, although it may also have a role in the fire control for the SS-N-22 missile system. It has already been supplied to India in the 'Nanuchka' class missile corvettes.

Bass Tilt fire-control radar
Bass Tilt is the NATO name for the Russian H-band naval fire-control radar which directs the fire of the AK-630 30 mm guns. The weapon system and director are mounted on a pedestal, with the drum-shaped antenna radome, 1.2 m in diameter, inclined at an angle of approximately 45°. The director is 2 m high and 1.45 m long. The radar is probably linked to a ballistic computer and each director controls one or two gun mountings.



Delhi *at launch on 1 February 1991. Progress in completing the ship has been slow, mainly due to delays in delivery of equipment from Russia*

SONARS

TSM 2633 hull-mounted sonar
TSM 2633 is the hull-mounted version of the Spherion VDS and is a long-range active sonar for ASW surface combatants. It comprises a spherical hull-mounted array with an electronic processing system that allows for real-time computation in transmission and reception modes; three-dimensional stabilisation to compensate for pitch, roll and yaw in the parent vessel; and a beam-tilting capability to counter adverse sound velocity profiles and strong reverberation.

Specifications
Acoustic array: Spherical with 160 individual transducers
Frequency: 7 kHz (approx)
Transmitter: Omnidirectional and sectoral transmissions in CW and FM modes, various modes including TRDT
Receiver: 36 preformed beams stabilised in azimuth and elevation; advanced processing with replica correlator in FM and spectrum analysis (FFT) in CW
Video processing: Data processing in FM and CW modes: automatic detection and tracking; simultaneous multitrack extraction (up to 64); target analysis (apparent length, Doppler measurement)
Display: High-resolution, flicker-free colour TV monitors
Total weight: 4,000 kg

Manufacturer/Contractor
Thomson-CSF Activités Sous-Marines, Sophia Antipolis Cedex, France.

Indal/Garden Reach Model 15-750
The 'Delhi' class is fitted with Indal's Model 15-750, which is a launch, towing and recovery system, including the towed body, for a VDS system. It is not known, however, what sonar package is used, although it could either be the same Fathoms Oceanic model used in the 'Godavari' class, or the Thomson-CSF VDS used in the last two ships of the 'Nilgiri' class.

Specifications
Tow speeds:
  launch and recovery: 8-14 kts
  operation: 6-20 kts
  survival: 30 kts
Cable length: 229 m
Sea state operation:
  launch/recovery: 4 (max)
  operation: 5 (max)

Manufacturer/Contractor
Indal Technologies Inc, Mississauga, Ontario, Canada.

AVIATION

AVIATION FACILITIES

There is a large flight deck and a hangar capable of accommodating two Sea King helicopters.

HELICOPTERS

Two Westland Sea Kings Mk 42B

Specifications
Main rotor diameter: 18.90 m (62.0 ft)
Length overall (both rotors turning): 22.15 m (72.66 ft)
Fuselage length: 17.02 m (55.83 ft)
Height to rotor head: 4.74 m (15.5 ft)
Weights:
  max take-off: 9,752 kg (21,500 lb)
  internal cargo capacity: 2,720 kg (6,000 lb)
Performance:
  max speed (never exceed): 144 kts (267 km/h)
  typical cruising speed: 120 kts (222 km/h)
  service ceiling: 3,720 m (12,200 ft)
  range (max standard fuel): 630 n miles (1,166 km)
Engines: 2—1,092 kW (1,465 shp) Rolls-Royce Gnome H.1400-IT turboshafts
Role equipment: 6 underwing pylons; torpedo bay; 32 sonobuoy ports; 2 depth-charge racks; search radar; FLIR; MAD
Accommodation: 4 (pilot; co-pilot; two sonar operators)
Sensors: MEL Super Searcher radar; Thomson-CSF H/S-12 dipping sonar; AQS-902B acoustic processor; Marconi Hermes ASM
Weapons: 2/4 homing torpedoes (Whitehead A244S or Russian APR-2); or 4 depth charges; or 2 Sea Eagle anti-ship missiles

PROPULSION

Specificatons
System: Combined diesel and gas turbine (CODAG)
Main machinery:
  first three ships: 2 Russian AM-50 gas turbines
  fourth and later ships: Hindustan Aeronautics/ General Electric LM-2500 49 MW (54,000 hp (m)); 2 Bergen/Garden Reach KVM-18 diesels; 7.73 MW (9,920 hp (m)) sustained
Shafts: 2

FURTHER INFORMATION

PROGRAMME

This programme represents yet another step forward in the capability of the Indian ship design and construction industries, and towards the Indian long-term national goal of naval self-sufficiency. Designated Project 15 by the Indian Navy, this programme originated in the early 1980s with the first ship being formally ordered in March 1986 and laid down in 1987. Russians are giving design and construction assistance, although the considerable delays in the programme are attributable to the breakdown in the central control of Russian export equipment. Normal work appears to have resumed in 1994 and the ships should be commissioned in 1997 (two), 1999 and 2002 although there could be further delays.

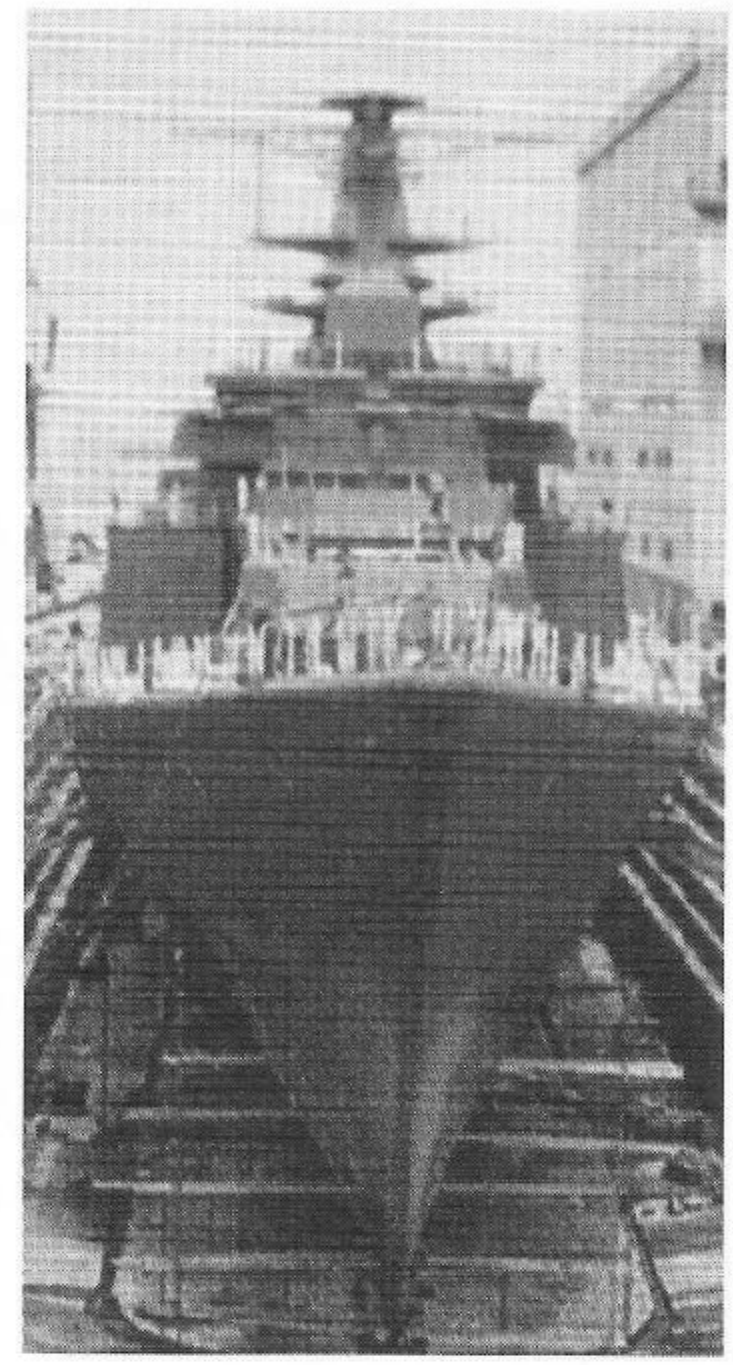
DESIGN

The Delhi design is described as essentially a 'stretched Rajput' but with many features from the *Godavari* and has an unusual mixture of Russian and Western weapons and sensors, but with some Indian systems indicating the way ahead.

As currently planned, the ships should have a predominantly Russian weapons fit, with SS-N-22 SSMs, SS-N-7 SAMs, a 100 mm gun and four AK-650 CIWS, but serious delays in the supply of Russian equipment may compel the Indian Navy to bring forward plans to fit these ships with Indian or Western weapons and electronic systems.

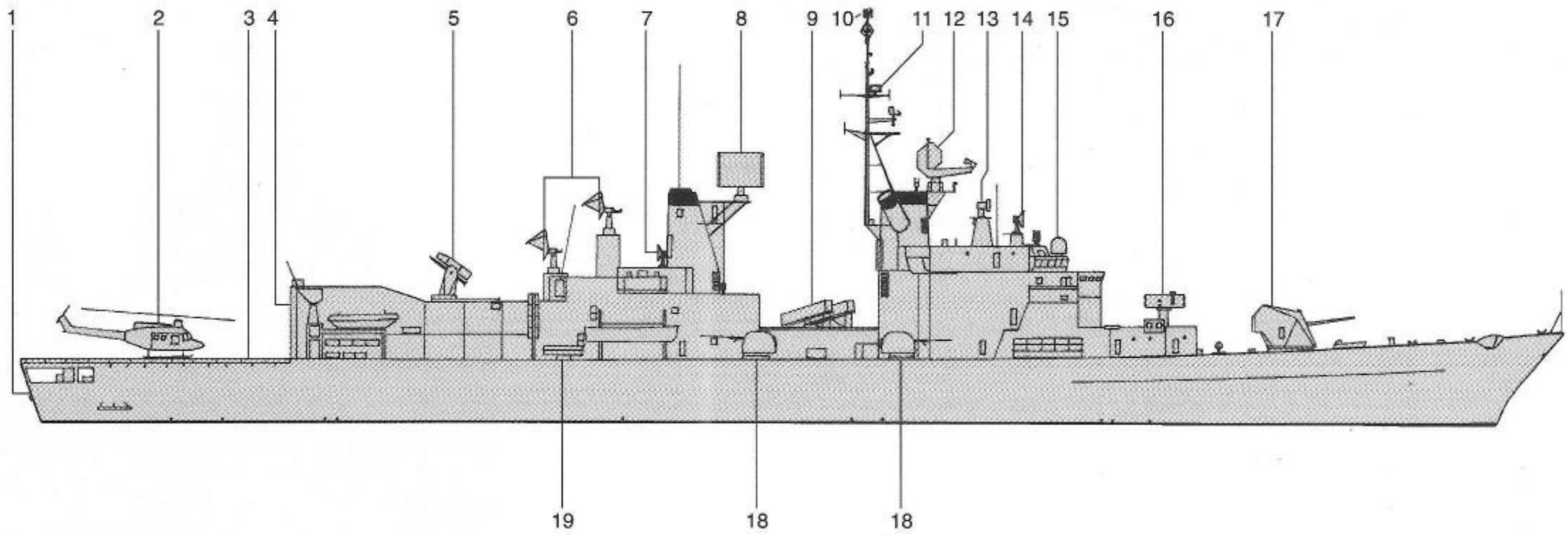
The gas turbines being fitted in the first three ships are Russian but these will probably be replaced, in the fourth and subsequent ships, by General Electric LM-2500 turbines built under licence in India by HAL. Similarly, the Russian missiles will be replaced by the Indian Koral and Trishul systems.

Early units in the class will carry the Westland Sea King helicopter, but this will be replaced in due course by the Indian-designed and -built Advanced Light Helicopter (ALH).



First of class Delhi *fitting out at the Mazagon shipyard in Bombay. It appears that there is no bow-mounted sonar. The launch-bins for the SS-N-22 either side of the bridge can be seen, together with the Band Stand radar*

AUDACE



Audace (Ian Sturton)
1 *SLQ-25 Nixie torpedo decoy* **2** *AB 212ASW helicopter* **3** *Flight deck* **4** *Hangar* **5** *Mk 13 Mod 4 launcher (Standard SM-1MR missiles)* **6** *Raytheon SPG-51 fire-control radar (for Standard)* **7** *Selenia SPG-76 (RTN-30X) fire control (Dardo E) (one)* **8** *Hughes SP5-52C radar (3D air search)* **9** *OTOBREDA/Matra Teseo Mk 2 (TG 2) (eight launchers)* **10** *SRN-15A TACAN* **11** *SMA SPQ-2D radar (surface search)* **12** *Selenia SPS-768 (RAN-3L) radar (air search)* **13** *Selenia SPS-774 (RAN-10S) radar (air/surface search)* **14** *Selenia SPG-76 (RTN-30X) fire director (Dards E) (two)* **15** *Satcom* **16** *Selenia Albatros eight-cell launcher (for Aspide missiles)* **17** *OTOBREDA 127 mm (5 in)/54 Compatts single gun mounting* **18** Audace: *OTOBREDA 76 mm (3 in)/62 Super Rapid (four),* Ardito*: OTOBREDA 76 mm (3 in)/62 Super Rapid (one) OTOBREDA 76 mm (3 in)/62 Compact (three)* **19** *US Mk 32 324 mm triple torpedo launcher (two)*

GENERAL SPECIFICATIONS

Operator: Italy

Class: AUDACE

Built: 2
Active: 2

Displacement:
standard: 3,600 t
full load: 4,400 t

Dimensions
Length: 136.6 m (448 ft)
Beam: 14.2 m (46.6 ft)

Draught: 4.6 m (15.1 ft)

Speed: 34 kts
Range: 3,000 n miles at 20 kts

Complement: 380 (30 officers)

SHIPS

ARDITO (D 550)

Builder	Italcantieri, Castellammare, Italy
Laid down	19 Jul 1968
Launched	27 Nov 1971
Commissioned	5 Dec 1972

AUDACE (D 551)

Builder	Fincantieri, Riva Trigoso/Muggiano, Italy
Laid down	27 Apr 1968
Launched	2 Oct 1971
Commissioned	16 Nov 1972

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

OTOBREDA Teseo Mk 2 (TG 2)

There are eight missiles, housed in four pairs of individual containers, mounted in the ship's waist facing at 90° to the ship's centreline.

The Teseo system is based on the Otomat missile, which has folding wings and is powered by a turbojet with solid fuel rocket boosters. The warhead is a semi-armour-piercing type which is claimed to penetrate up to 8 cm of nickel-chromium armour. The Mk 2 system is designed for over-the-horizon targeting using a co-operating Agusta-Bell AB 212ASW helicopter with SMA 38/APS-705 I-band radar and PRT-405 tracking and datalink system. On the first leg, the missile flies directly towards the helicopter and only when it passes under the helicopter does the latter transmit target location data.

The target may be acquired by the ship's radar, by the radars of friendly ships or by helicopter radars. Data on the target's location are transmitted to the missile's autopilot and the turbojet is started. Once it has reached full power the boosters are ignited and the missile is launched but, as the missile can turn through angles of up to ±200°, the warship does not have to be facing the target during the launch phase.

Once launched, the missile climbs to 150 m accelerated by the boosters which burn for 4 seconds, until it reaches cruising speed at a distance of some 2.15 n miles (4 km) from the launch point, where the boosters are jettisoned. The missile then descends to a cruising altitude of 15-20 m, a compromise between ensuring good communications with the mothership and the need to make it difficult for the target to detect it. The missile continues towards the target with mid-course guidance correction until the radar seeker, which is azimuth only, is activated at a predetermined point and scans a 40° sector, then acquires the target at a range of about 6.5 n miles (12 km). For the terminal phase the Otomat drops to sea-skimming height.

The Otomat system is capable of engaging two separate targets simultaneously in sea states up to Force 7.

Specifications

Length: 4.46 m (14.63 ft)
Diameter: 46 cm (18 in)
Wing span: 1.36 m (4.42 ft)
Weight:
without boosters: 762 kg (1,680 lb)
with boosters: 770 kg (1,700 lb)
Range: 86 n miles (160 km)
Speed: Mach 0.9
Guidance: Inertial and active radar homing
Propulsion: Turbomeca TR 281 Arbizon III turbojet; 400 kg st
Boosters: 2 SNPE solid propellant boosters; 3,500 kg st each
Warhead: Semi-armour-piercing; 210 kg (463 lb); HE 65 kg (143 lb)
Fuzes: Impact, proximity

Manufacturer/Contractor

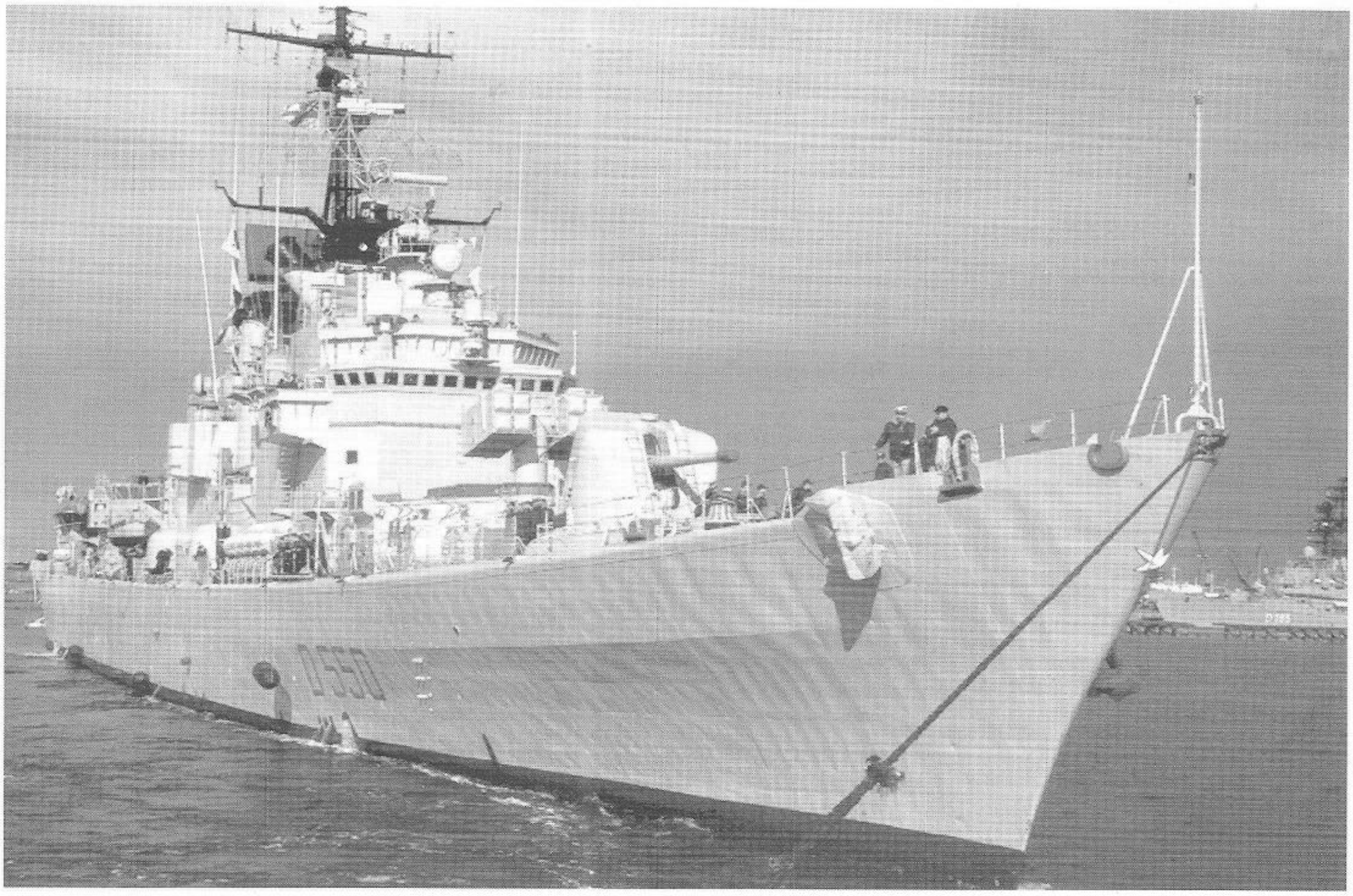
OTOBREDA, La Spezia, Italy.

Standard Missile-1 Medium Range (SM-1MR)

Main air defence weapon is the Standard SM-1MR surface-to-air missile, which is launched from a 13 Mod 4 launcher located immediately forward of the hangar, with a 40-round magazine directly underneath it. The Standard SM-1MR is the original version of the missile with a combined booster-sustainer rocket motor. The missile has a Raytheon conical scan, solid-state, semi-active radar seeker with scan receiver, speed gate and analogue guidance computer, and an expanding rod warhead in the ordnance section. The fire-control system uses two SPG-51C radars, which are positioned one behind the other facing the stern abaft the after stack.

Specifications

(SM-1MR)
Length: 4.46 m (14.66 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.57 m (5.15 ft)
Weight: 1,343.6 kg (2,962 lb)



Ardito *(D 550). On the foredeck are an OTOBREDA 127 mm automatic gun and the Albatros eight-cell launcher for Aspide SAMs. A second 127 mm gun was removed from the 'B' position in 1988 to make way for the SAM system* (Jane's/H M Steele)

Speed: Mach 2.5
Range: 34.5 n miles (64 km)
Altitude: 24,400 m (80,000 ft)

Manufacturer/Contractor
Hughes Missile Systems
Raytheon Missile Systems Division.

SURFACE-TO-AIR MISSILES (SAM)

Alenia Elsag Albatros SAM system
There is one Alenia Elsag Albatros eight-cell launcher on the foredeck, with Aspide missiles in the magazine beneath it. This modular system interfaces with and complements the gun system to produce an overlapping, layered, air defence against both aircraft and anti-ship missiles. The seeker has a home-on-jam capability and the missile delivers a Difesa e Spazio 33 kg (73 lb) preformed fragmentation warhead. Illumination energy is routed to the tracker antenna through an I/J-band waveguide. The system has a very short reaction time, the radar becoming operational within 2 seconds. Albatros is used with one or two directors, the launcher being automatically slaved to one director during the operation. The launcher unit has eight cells, four on each side of the mounting, each with a frangible front and rear cover and a loading guide to which the launching rail of the missile is electrically and mechanically connected.

Specifications
Length: 3.7 m (12.1 ft)
Diameter: 20.3 cm (8 in)
Wing span: 80 cm (31.5 in)
Weight: 220 kg (485 lb)
Speed: Mach 2.5
Max range: 15 km (horizontal)
Altitude: 15-5,000 m (50-16,405 ft)
Warhead: 33 kg (72.8 lb)
Guidance: Semi-active radar
System reaction time: 8 s
Max firing rate: 1 missile every 2.5 s

Manufacturer/Contractor
Alenia Elsag Sistemi Navali, Rome, Italy.

TUBES

Six 324 mm US Mk 32 torpedo tubes are sited in two triple mounts on either beam below the after SPG-51C illuminator-director. Note that the tubes previously located in the transom have been removed.

Ardito *(D 550)* (Jane's/H M Steele)

Specifications
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

Alliant Techsystems 46 Mod 5 324 mm torpedoes

Specifications
Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507.0 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: Liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

GUNS

OTOBREDA 127 mm/54 Compatto
There is one OTOBREDA 127 mm/54 Compatto mounting in 'A' position. This weapon is designed to provide naval gunfire support, to engage surface targets and to engage air targets, including anti-ship missiles and fixed-wing aircraft which do not have standoff weapons. The turret is unmanned and is enclosed by a glass fibre shield. Much of the turret and the lower part of the mounting are made of aluminium alloy. The below-deck element of the mounting consists of three drums, each containing 22 rounds, which are stocked automatically from two chain-driven lower hoists which lead to the magazines and are loaded manually. The gun captain uses his control to select which drums are to be replenished and with what ammunition. Japanese versions are reported to have an improved console with modernised electronics including BITE facilities. The weapon is compatible with all US 5 in L/54 ammunition.

Specifications
Gun
Calibre: 127 mm
Length of barrel: 54 calibres
Muzzle velocity: 808 m/s (2,625 ft/s)
Range:
anti-air: 13,600 m (45,000 ft)
anti-surface: 8.6 n miles (16 km) surface/surface
Rate of fire: 45 rds/min
Weight of shell: 32 kg (70 lb)

Mounting
Compatto
Training: 330° at 40°/s
Elevation: −15 to +85° at 30°/s
Crew: 5

Manufacturer/Contractor
OTOBREDA, La Spezia, Italy.

OTOBREDA 76 mm (3 in)/62
The number and type of 76 mm guns differs between the two ships:
Ardito — three OTOBREDA 76 mm/62 Compact; one OTOBREDA 76 mm/62 Super Rapid
Audace — four OTOBREDA 76 mm/62 Super Rapid

In both ships the guns are located in the waist and are part of the Dardo fire-control system.

Specifications

	Compact	Super Rapid
Calibre	76.2 mm (3.0 in)	76.2 mm (3.0 in)
Length of barrel	4.72 m (15.49 ft)	4.72 m (15.49 ft)
Elevation	−15 to +85°	−15 to +85°
Training speed	70°/s	60°/s
Elevation speed	40°/s	35°/s
Muzzle velocity	900 m/s (2,953 ft/s)	925 m/s 3,035 ft/s)
Max rate of fire	85 rds/min	120 rds/min
Range	8.6 n miles (16 km)	8.5 n miles (15.74 km)

ELECTRONIC WARFARE SYSTEMS

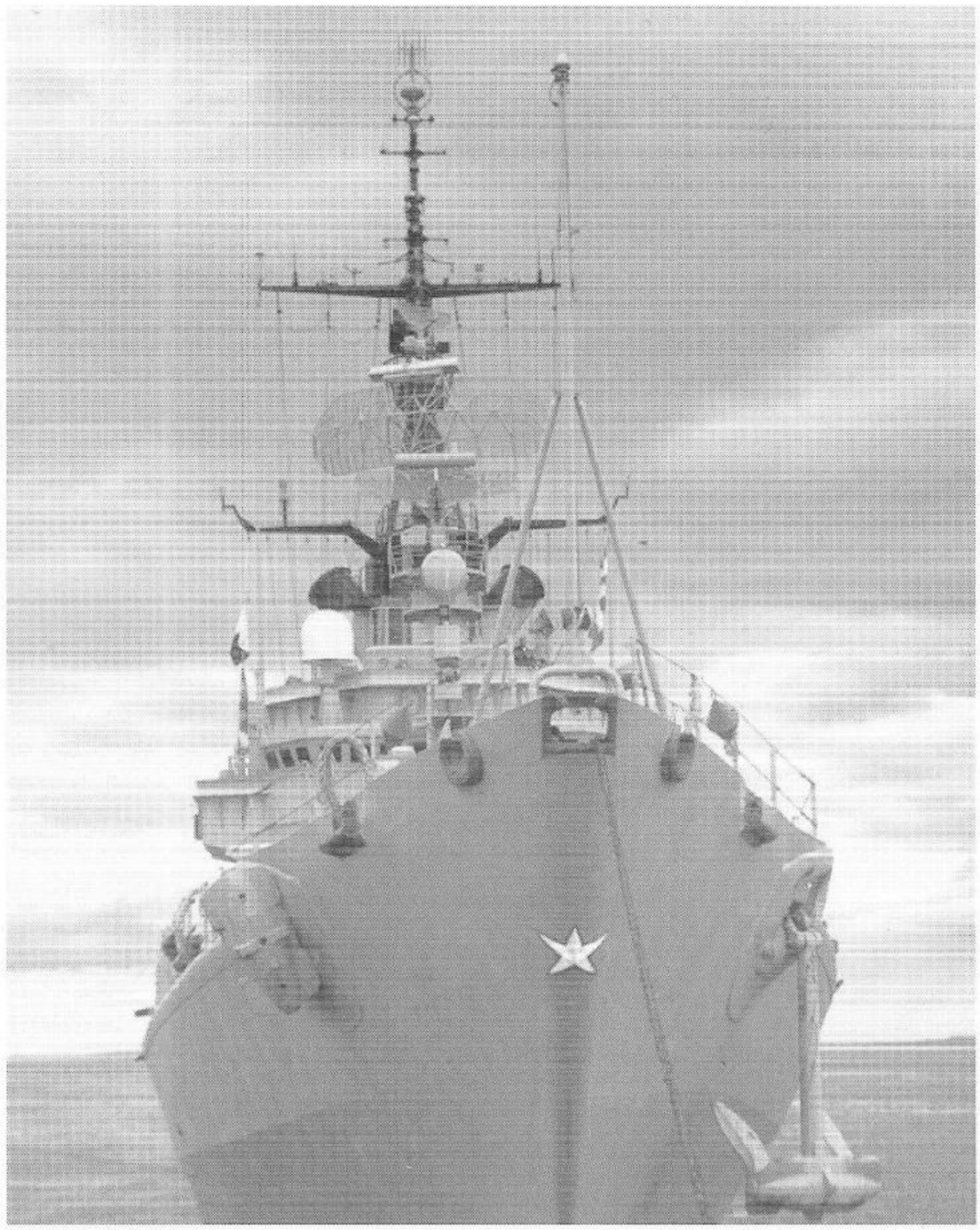
ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

Elettronica Nettuno SLQ-732 radar detection and countermeasures system
The Nettuno integrated radar ESM/ECM system is claimed to have a 100 per cent probability of intercepting all emitters, using passive surveillance based on environmental synthesis. A very high level of automation ensures both immediate and automatic identification based on a powerful threat library, and accurate tracking of emitters. Computer-controlled processing employs structured modular software using a high-level language. There is full, interactive integration with the command and control systems, and also with the flare/chaff launcher systems. Roll-stabilised, multibeam DF antennas provide high-bearing accuracy and feature high sensitivity, wide dynamic range logarithmic amplifiers and completely digital processing. The ECM section provides self-protection by environment adaptive instant-by-instant automatic jamming, even against simultaneous multiple threats. However, command and control, or the operator, can override the system if necessary. The high-power jammer antennas are roll-stabilised and consist of linear arrays that electronically steer a precise and narrow high-gain beam. Jamming implementation follows automatic instructions provided by the ESM section and by the power management computer. High ERP is achieved by using a transmitter design employing paralleled matched high-power Elettronica-designed TWTs.

Manufacturer/Contractor
Elettronica SpA, Rome, Italy.

DECOYS

OTOBREDA 105 mm Rocket Launcher (SCLAR)
There are two SCLAR 105 mm rocket launcher systems, one either side of the hangar. The system provides defence against radar and IR homing missiles, confuses enemy radars, and provides illumination for visual fire control at night. Different types of rockets can be loaded in various arrangements (long-range chaff, medium-range chaff, illuminating) to permit mixed salvos. The remote fire-control unit is used to select the number and types of rockets to be loaded and to set the fuzes and carry out the launch sequence. The 20-tube



Ardito *(D 550). Note the Satcom antenna above the bridge windows and the unusual array at the masthead, where the low-band DF antennas of the Nettuno ESM/ECM system are inset inside a DF loop* (Jane's/H M Steele)

launchers are trained and elevated by remote control. The control unit is linked to the ship's radar and a control panel in the ECM compartment to provide the necessary operating signals. The data needed to stabilise the two launchers against pitch and roll is provided by the ship's gyrocompass.

There are four types of rocket, all of which have double-base propellant motors, folding fins and electronic fuzes, while their speed to burnout is 260-645 m/s. These rockets are shown in the Table.

Specifications

Launcher
Traverse: 300° at 60°/s
Elevation: −5 to +60° at 30°/s
Number of tubes: 20
Diameter: 105 mm
Rate of fire: 1 rd/s (approx)

Manufacturers/Contractors

OTOBREDA, Rome, Italy (launcher).
SNIA BPD (rockets).

AN/SLQ-25 Nixie noisemaker

One AN/SLQ-25 Nixie (Phase 1), a solid-state, modular design electroacoustic countermeasures decoy system is used to protect the ship from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads and the transmitter are located. Each winch can stream and recover the 488 m (1,600 ft) cable at 30.5 m/min (100 ft/min), each cable weighing 408 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 95 cm long (3.10 ft), 15.24 cm (6 in) in diameter and weigh 18 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body at a time is deployed.

Rockets

Rocket	Role	Range	Length	Weight of complete round	Payload
SNIA 105 LR-C	Chaff distraction	12,000 m (13,120 yd)	1.85 m (6.07 ft)	27 kg (60 lb)	10.2 kg (22.5 lb)
SNIA 105 MR-C	Chaff seduction	4,700 m (5,140 yd)	1.83 m (6.0 ft)	29 kg (64 lb)	17.4 kg (38.4 lb)
SNIA 105 MR-IR	infra-red seduction	5,000 m (5,470 yd)	1.83 m (6.0 ft)	29 kg (64 lb)	10.2 kg (22.5 lb)
SNIA LR-I	Illuminating	4,000 m (4,370 yd)	1.85 m (6.07 ft)	27 kg (60 lb)	10.2 kg (22.5 lb)

Manufacturer/Contractor

Aerojet ElectroSystems, Sacramento, California, USA.

COMMAND AND CONTROL SYSTEMS

COMMAND DATA SYSTEMS

SADOC 2/IPN 20

SADOC 2/IPN 20 (SADOC = *Systema Direzione della Operazioni di Combattimento)* is designed to produce an up-to-date picture of the tactical situation within the vicinity of both the ship and task group, and uses a mainframe architecture to acquire, process and present data acquired by sensors. It is also used for threat evaluation, weapons control, ECM management, aircraft control, conducting ASW operations, and datalink databank management. Data are received from onboard sensors and also from offboard sensors via Link 11, 14 or 16. In addition, track information is exchanged with NADGE (NATO Air Defence Ground Environment) sector operational centres via a Link 11/Link 1 Ship-Shore-Ship Buffer, which also enables the ship to direct shore-based aircraft allocated to its control. There is a 10 Mbit/s serial databus. The basic software of the latter is under the control of two TAVITAC operating systems; the disk operating system and a time-sharing executive. The CPUs are supported by a Tape Cassette Unit (TCU) with three transporters to provide initial programme loading by means of cartridge cassette magnetic tape. They are also used for data recording and retrieval. Input/output (I/O) expander and converter units interface with external systems and an I/O terminal to monitor the system and to provide offline hard copy records. The system is also associated with radar tracking units (RTU) for radar video extraction and automatic tracking and radar central units (RCU) for distributing radar data.

Manufacturer/Contractor

Alenia Elsag Sistemi Navali, Rome, Italy.

COMMUNICATIONS AND DATALINKS

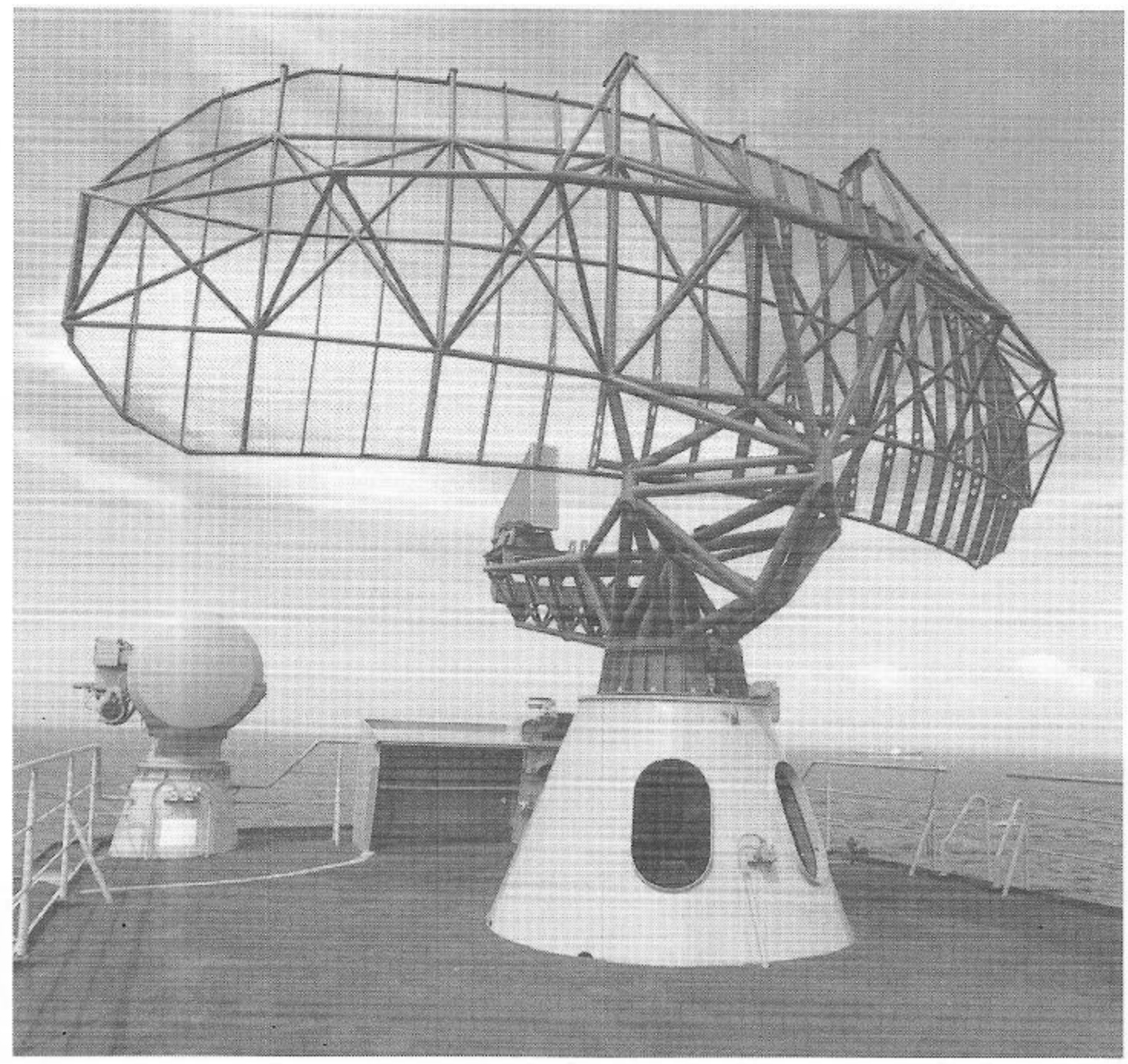
Datalinks: Link 11; Link 14
Satcom
IFF: XII
Tacan: SRN-15A

WEAPONS CONTROL

Dardo E weapon control system

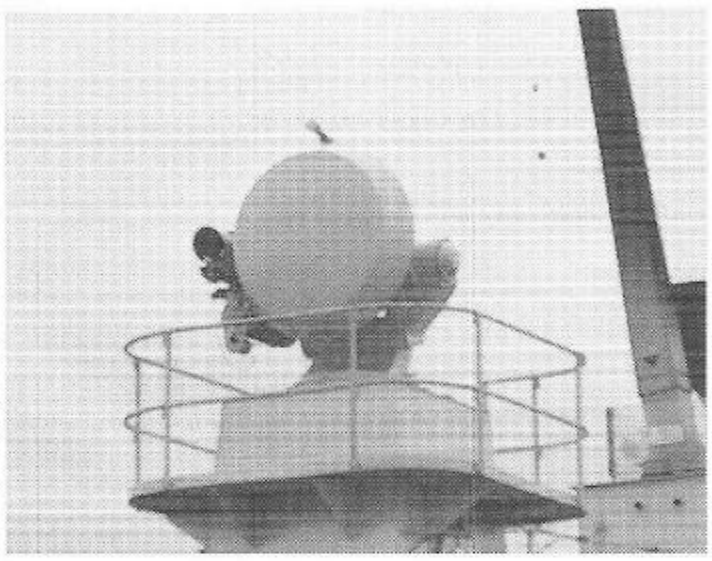
There are three Dardo E automatic CIWS, with manual override, designed to engage sea-skimming and diving

SPQ-2 antenna (SMA)



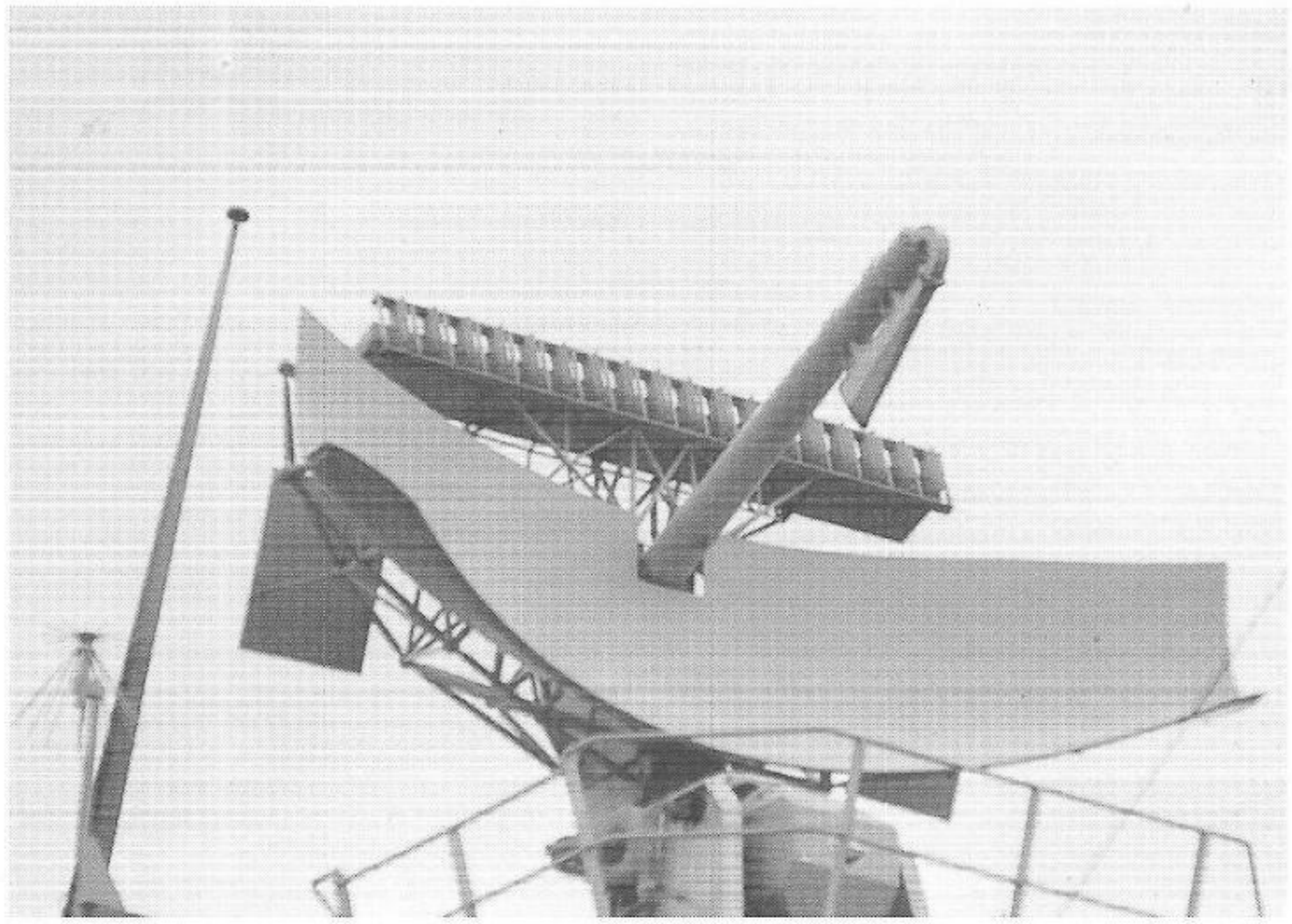
RAN-3L antenna (Selenia)

SPS-52 radar and two SPG-51 (Stefan Terzibaschitsch)



RTN-30X radar

missiles as well as manned aircraft. It is a digital system, using a mainframe computer and the Orion RTN 20X radar. Each system controls a single twin 40 mm gun mounting and optional equipment includes optical designators.



RAN-10S antenna (Stefan Terzibaschitsch)

The software is written in Assembler language and, in addition to input from the sensors, there are inputs from the gyrocompass, inertial reference, the log and the wind reference unit. Initial target acquisition is by the ship's search radar which interfaces directly with the system which is also linked to the tactical data handling system. Once the RTN 20 radar has acquired the target/targets, the system tracks them automatically, assigning priorities where necessary, although the operator can override the system to engage lower priority targets, if necessary. Targets can be engaged at distances of 300-3,500 m and up to 10 may be tracked simultaneously.

SONARS

CWE-610 Sonar

CWE-610 is designed for long-range detection of submarines in deep and shallow water. The scanning sonar has two active consoles, enabling it to perform a search-while-track function and facilities offered include a search capability in three 120° sectors, passive correlation and reverberation processing. The transmitter and receiver beams are preformed. Output is available for a fire-control system. All mode changes and range scale changes are controlled by console push-buttons, and displays include a Doppler display on each of the active consoles and a passive sonar bearing time recorder display.

Specifications

Transducer:
- **diameter:** 1.25 m (4.1 ft)
- **height:** 1.1 m (3.6 ft)
- **staves:** 36

Coverage: 360° (azimuth)
Range: 183-3,000 m (200-3,200 yd)
Doppler range: ±40 kts (7.2 kHz)
Displays: Range (A Scan); Bearing (B Scan)
Doppler Frequencies: 6.4, 7.2 and 8.0 kHz
Bearing accuracy: 1° RMS
Range accuracy: ±1% range reading

Manufacturer/Contractor

EDO, Government Systems Division, College Point, New York, USA.

RADARS

Set	SPS-52C	SPS-768 (RAN-3L)	SPS-774 (RAN-10S)	SPQ-2D	SPN-748	Three SPG-76 (RTN-30X)	Two SPG-51C
Company	Hughes	Selenia	Selenia	SMA	SMA	Selenia	Sperry
Role	Long-range air search	Air search	Air/surface search	Surface search, target indication	Navigation	Fire control (Dardo E)	Fire control (Standard)
Band	E/F	D	E/F	I	I	I/J	G/H
Range	240 n miles (440 km)	120 n miles (220 km)	85 n miles (155 km)	—	40 n miles (73 km)	22 n miles (40 km)	28 n miles (51 km)
Beam	1.1 × 2.25°	2.15 × 9° plus csc²	1.5 × 17°	0.6°	—	—	1.6/0.8°
Peak power	1,000 kW	135 kW	140 kW	Tac: 180 kW Nav: 50 kW	—	12 kW	1 MW
Gain	39.5 dB	30 dB	28 dB	—	—	—	39 dB
Pulsewidth	2.5/4.6/10 µs	78.4 (1.6) µs	0.4 µs	Tac: 0.15/1.5 µs	—	0.5/6.5 µs	26/1.5 µs
PRF	1,850/925 pps	—	900 pps	2,500-3,000/ 450-500 pps	—	—	203-225 pps
Scan rate	15/6 rpm	6 rpm	15/30 rpm	up to 40 rpm	—	—	—

AVIATION

AVIATION FACILITIES

Specifications

Flight deck: 24.7 × 14.2 m (81.1 × 46.6 ft)

HELICOPTERS

Agusta-Bell AB 212ASW

Two Agusta-Bell AB 212ASW anti-submarine, anti-ship or electronic warfare helicopters are normally embarked.

Specifications

Main rotor diameter: 14.63 m (48.0 ft)
Height to rotor head: 3.91 m (12.82 ft)
Rotor disc area: 168.1 m² (1,809 sq ft)
Max take-off weight: 5,070 kg (11,177 lb)
Max speed (never exceed): 130 kts (240 km/h)
Typical cruising speed: 100 kts (185 km/h)
Hovering ceiling (out of ground effect): 396 m (1,300 ft)
Range with max standard fuel: 332 n miles (615 km)
Engine: 1 Pratt & Whitney Canada PT6T-6 Turbo Twin-Pac rated at 1,398 kW (1,875 shp)

Role equipment: AS-12 ASMs or Elettronica Gufo 2000 EW intercept equipment

PROPULSION

Specifications

System: Steam turbines
Main machinery: 4 Foster-Wheeler boilers; 43 kg/cm² (600 psi); 450°C (850°F); 2 turbines; 54 MW (73,000 hp (m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

It was announced in April 1966 that two new guided missile destroyers would be built. They are basically similar to, but an improvement in design on, the 'Impavido' class (now deleted).

DESIGN

The Audace design is similar to the 'Impavido' class, but the hull is larger and more seaworthy, and has a higher freeboard. The armament is all of Italian design except for the US Standard missile system and the Mk 46 torpedoes. The sensors are also of Italian design except for the CWE-610 sonar, which is of US origin.

As built, the gun armament was very heavy for the size of ship, with two single 127 mm mountings forward and four 76 mm mountings in the waist, although one of the 127 mm guns has since been removed. Both ships are fitted with roll dampers.

MODERNISATION

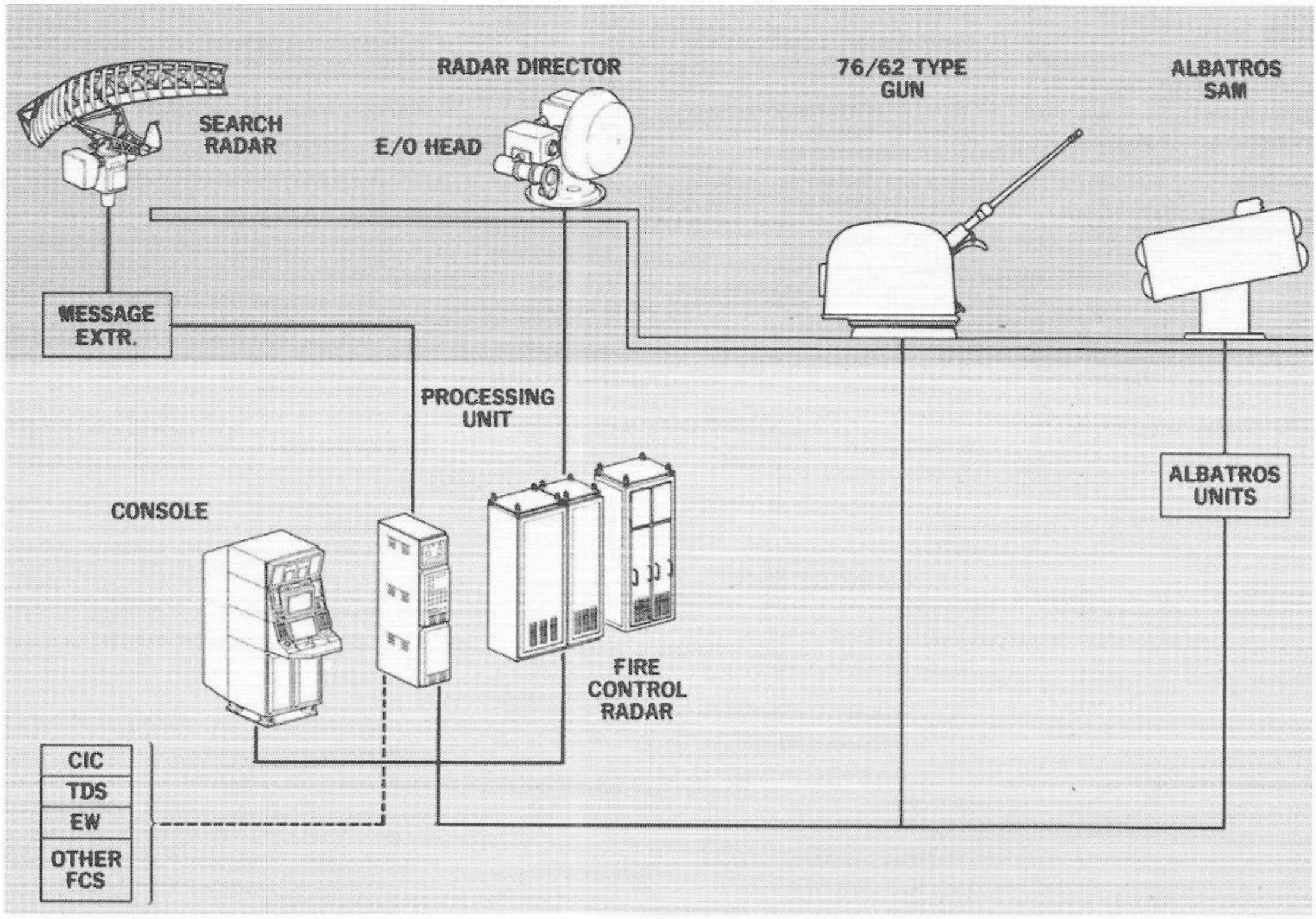
Both ships have undergone a mid-life modernisation programme which was completed for *Ardito* in March 1988 and for *Audace* in early 1991. The second 127 mm gun in 'B' position was removed and replaced by a launcher and magazine for the Albatros PDMS (point defence missile system), the two mountings subsequently being used in the two new 'De La Penne' class destroyers (see following entry). The four torpedo tubes in the stern were also removed.

During these refits, all four of *Audace's* 76 mm Compact mountings were removed and replaced by four 76 mm Super Rapid mountings. *Ardito,* however, has only one Compact mount replaced by a Super Rapid and plans to replace the other three by 1994 have since been shelved.

Improved EW equipment has also been fitted.

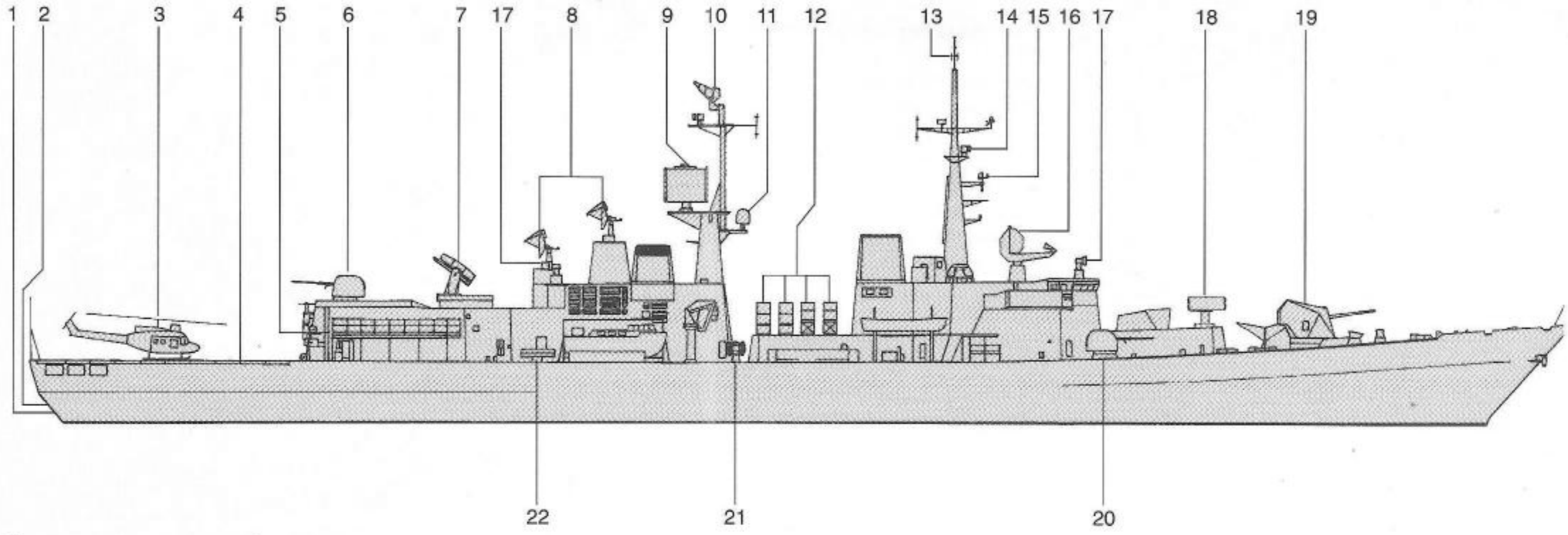
OPERATIONAL

The first deck landing trials of the Anglo-Italian EH 101 helicopter were carried out on board *Ardito* on 14 May 1992.



Dardo E fire-control system

DE LA PENNE



Francesco Mimbelli (Ian Sturton)
1 *SLQ-25 Nixie torpedo decoy* **2** *Raytheon DE 1164 VDS* **3** *Agusta-Bell AB212 ASW helicopter (two)* **4** *Flight deck* **5** *Hangar* **6** *OTOBREDA 76 mm (3 in)/62 Super Rapid single automatic gun (one)* **7** *Mk 13 Mod 4 launcher for Standard SM-1MR* **8** *Raytheon SPG-51D fire-control radar (for Standard)* **9** *Hughes SPS-52C radar (air search)* **10** *Selenia SPS-774 (RAN-10S) radar (air/surface search)* **11** *Satcom* **12** *OTOBREDA/Matra Teseo Mk 2 (TG 2) (four or eight missiles)* **13** *SRN-15A TACAN* **14** *Elettronica SLQ-732 Nettuns ESM/ECM system* **15** *SMA SPS-702 radar (surface search)* **16** *Selenia SPS-768 (RAN-3L) radar (air search)* **17** *Selenia SPG-76 (RTN-30X) fire control (for Dards system) (four sets)* **18** *Selenia Albatros Mk 2 eight-cell launcher (Aspide missiles)* **19** *OTOBREDA 127 mm (5 in) Compact single gun automatic mounting (one)* **20** *OTOBREDA 76 mm (3 in)/62 Super Rapid single gun automatic mounting (two)* **21** *CSEE Défense Sagaie chaff launcher (two)* **22** *B-515 324 mm triple torpedo launcher (two)*

GENERAL SPECIFICATIONS

Operator: Italy

Class: DE LA PENNE

Built: 2
Active: 2

Displacement:
standard: 4,300 t
full load: 5,400 t

Dimensions
Length: 147.7 m (487.4 ft)
Beam: 16.1 m (52.8 ft)
Draught: 7.1 m (23.3 ft)

Speed:
diesels: 21 kts
max: 31 kts
Range: 7,000 n miles at 18kts

Complement: 377 (32 officers)

SHIPS

LUIGI DURAND DE LA PENNE (D 560)

Builder	Fincantieri, Riva Trigoso/Muggiano, Italy
Laid down	20 Jan 1988
Launched	29 Oct 1989
Commissioned	18 Mar 1993

FRANCESCO MIMBELLI (D 561)

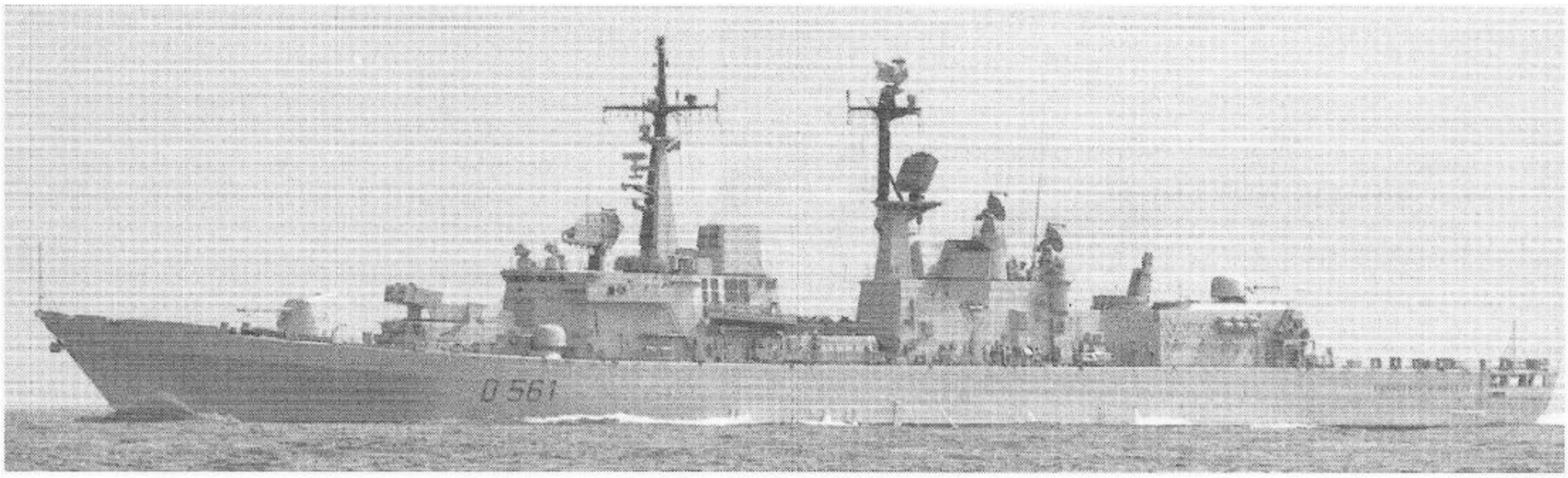
Builder	Fincantieri, Riva Trigoso/Muggiano, Italy
Laid down	15 Nov 1989
Launched	13 Apr 1991
Commissioned	19 Oct 1993

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

OTOBREDA Teseo Mk 2 (TG 2)

These two ships mount either four or eight Teseo launchers, in either two or four pairs of individual containers. These are mounted in the waist, half pointing to port, half to starboard at 90° to the ship's centreline. The Teseo system is based on the Otomat missile which has folding wings and is powered by a turbojet with solid fuel rocket boosters. The warhead is a semi-armour-piercing type which is claimed to penetrate up to 8 cm of nickel-chromium armour. The Mk 2 system is designed for over-the-horizon targeting using a cooperating Agusta-Bell AB 212ASW helicopter with SMA 38/APS-705 I-band radar and PRT-405 tracking and datalink system. On the first leg, the missile flies directly towards the helicopter and only when it passes



Francesco Mimbelli *(D 561), is one of two 'De La Penne' class destroyers of the Italian Navy. Displacing 5,400 t, they are heavily armed with a mixture of missiles (eight Teseo Mk 2 SSM, Standard SM-1MR, Aspide short-range missiles); guns (one 127 mm (5 in); three 76 mm (3 in)); torpedoes (two triple launchers); and two AB-212ASW helicopters* (Erminio Bagnasco)

under the helicopter does the latter transmit target location data.

The target may be acquired by the ship's radar, by the radars of friendly ships or by helicopter radars. Data on the target's location are transmitted to the missile's autopilot and the turbojet is started. Once it has reached full power the boosters are ignited and the missile is launched but, as the missile can turn through angles of up to ±200°, the warship does not have to be facing the target during the launch phase.

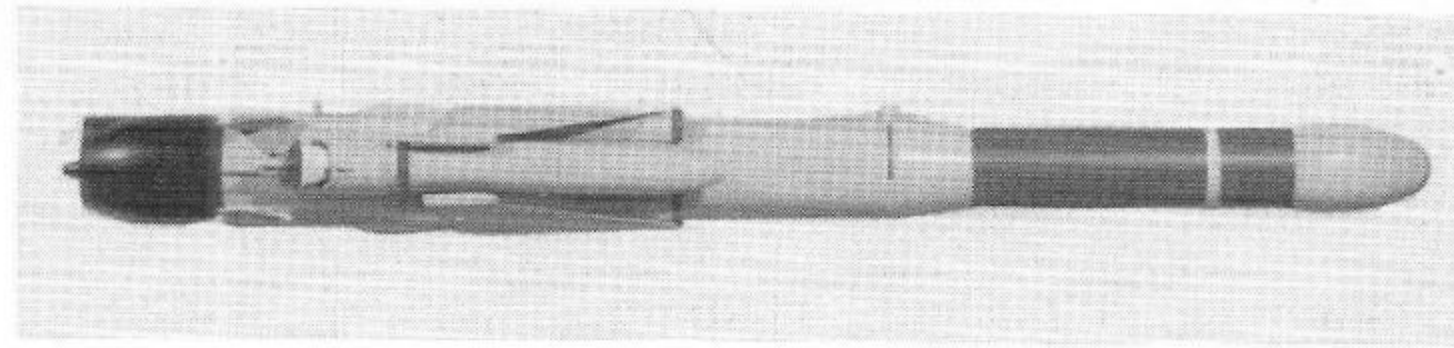
Once launched, the missile climbs to 150 m, accelerated by the boosters which burn for 4 seconds, until it reaches cruising speed at a distance of some 2.15 n miles (4 km) from the launch point, where the boosters are jettisoned. The missile then descends to a cruising altitude of 15-20 m, a compromise between ensuring good communications with the mothership and the need to make it difficult for the target to detect it. The missile continues towards the target with mid-course guidance correction until the radar seeker, which is azimuth only, is activated at a predetermined point and scans a 40° sector, then acquires the target at a range of about 12 km (6.5 n miles). For the terminal phase the Otomat drops to sea-skimming height. The Teseo system is capable of engaging two separate targets simultaneously in sea states up to Force 7.

Specifications
Length: 4.46 m (14.63 ft)
Diameter: 46 cm (18 in)
Wing span: 1.36 m (4.46 ft)
Weight without boosters: 762 kg (1,680 lb)
Range: 86 n miles (160 km)
Speed: Mach 0.9
Guidance: Inertial and active radar homing
Propulsion: Turbomeca TR 281 Arbizon III turbojet; 400 kg st
Boosters: 2 SNPE solid propellant boosters; 3,500 kg st each
Warhead: Semi-armour-piercing; 210 kg (463 lb); HE 65 kg (143 lb)
Fuzes: Impact, proximity

Manufacturer/Contractor
OTOBREDA, La Spezia, Italy.

SURFACE-TO-AIR MISSILES (SAM)

Standard Missile-1 Medium Range (SM-1MR)
Main air defence armament is the SM-1MR which is launched from the Mk 13 Mod 3/4 launcher just forward of the hangar, with a magazine below, holding 40 missiles. When the target is detected, the data is evaluated by the ship's command system and the target is designated for the missile fire-control system, which then tracks and illuminates it. Each SPG-51C tracker/illuminator radar usually controls one missile. Once the missile is launched, the tracker's main illumination beam holds the target while the rear reference illuminator beam provides guidance data through the missile's rear reference antenna. This guides the missile until the onboard seeker detects the CW reflected energy from the main illuminator beam. The onboard guidance system then brings the missile to an interception course. SM-1MR Block IV missiles have a Naval Weapon Center Mk 51 expanding rod warhead, while Block V missiles have a Naval Weapon Center Mk 90 blast fragmentation warhead.



A mock-up of MILAS, which is, in essence, a combination of a 324 mm torpedo and an OTOMAT missile

Specifications
Length: 4.48 m (14.7 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.06 m (3.48 ft)
Weight: 642.3 kg (1,416 lb)
Speed: Mach 2
Range: 20.5 n miles (38 km)
Altitude: 19,800 m (65,000 ft)

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA.
Raytheon, Missile Systems Division, Bedford, Maryland, USA.

Alenia Elsag Albatros Mk 2
There is one Albatros Mk 2 launcher for Aspide surface-to-air missiles in 'B' position, with a magazine below containing 16 missiles. This modular system interfaces with and complements the gun system to produce an overlapping, layered, air defence against both aircraft and anti-ship missiles. The seeker has a home-on-jam capability and the missile delivers a Difesa e Spazio 33 kg preformed fragmentation warhead. Illumination energy is routed to the tracker antenna through an I/J-band waveguide. The system has a very short reaction time, the radar becoming operational within 2 seconds. Albatros is used with one or two directors, the launcher being automatically slaved to one director during the operation. The launcher unit has eight cells, four on each side of the mounting, each with a frangible front and rear cover and a loading guide to which the launching rail of the missile is electrically and mechanically connected.

Specifications
Length: 3.7 m (12.1 ft)
Diameter: 20.3 cm (8 in)
Wing span: 80 cm (31.5 in)
Weight: 220 kg (485 lb)
Speed: Mach 2.5
Max range: 15 km (horizontal)
Altitude: 15-5,000 m (50-16,405 ft)
Warhead: 33 kg (72.8 lb)
Guidance: Semi-active radar
System reaction time: 8 s
Max firing rate: 1 missile every 2.5 s

Manufacturer/Contractor
Alenia Elsag Sistemi Navali, Rome, Italy.

ANTI-SUBMARINE MISSILES

MILAS
Milas is a new anti-submarine system which started sea-going trials aboard *De La Penne* (D 560) in 1996. The missile is essentially an Otomat Mk 2 from which the seeker and warhead have been removed and replaced by a 324 mm lightweight torpedo. The missile is boosted from its launcher by two 75 kg (165 lb) SNPE solid propellant boosters which then drop away, with a Turbomeca TR 281 Arbizon III turbojet (400 kg st) providing power in the cruise phase.

The torpedo is the Mu 90 Impact, based upon the French Murène torpedo, but with an Italian seeker. The torpedo is approximately 2.8 m (9.18 ft) long and is powered by an aluminium/silver-oxide battery. It will weigh about 300 kg (661 lb) with the parachute pack weighing another 15 kg (33 lb) (approximate). Targets are detected and classified by the ship's sonar system with range, depth and distance data then transmitted to the missile's inertial navigation unit. There is also provision for several mid-course updates to be passed by datalink from either the parent ship or a co-operating aircraft.

Once in the target area the turbojet is shut down and the torpedo separates from the missile carrier and its descent is slowed by the drogue parachute. On entering the water the torpedo's sensor is activated and it begins its programmed search pattern. The manufacturers claim that it will take less than three minutes between the launch of the missile and the torpedo entering the water at a distance of 19 n miles (35 km) from the ship.

Specifications
Length: 6 m (19.7 ft)
Diameter: 46 cm (18 in)
Wing span: 1.35 m (4.43 ft)
Launch weight: 800 kg (1,764 lb)
Speed: Mach 0.9 (300 m/s)
Range: 2.5-29.5 n miles (5-55 km)
Guidance: Inertial with command updates

Manufacturer/Contractor
GIE Milas (jointly owned by Matra Défense (78-Velizy, France) and OTOBREDA, (La Spezia, Italy).

B 515 surface vessel torpedo launching system
Two triple B 515 torpedo launchers are mounted on the upper deck abreast the after SPG-51 director, one set on either beam. The B 515 torpedo launching system consists of three 324 mm torpedo tubes which launch lightweight anti-submarine torpedoes such as the A 244/S, A 244/S Mod 1, 44, 46 and Impact Mu 90. There are two launchers, one on the starboard and the other on the port side of the ship, both being arranged with the muzzle facing forward. The tubes are mounted on a base which can be manually trained by means of a suitable retractable handle, with the torpedo being fired after the tube has been trained into the designated sector.

Firing is achieved using compressed air stored in air bottles secured to the tube's outer surface and refilled via the air charging station (also made by Whitehead). Torpedo launching is controlled either electrically, by means of the Shipborne Remote-Control Panel (Whitehead production), or manually, acting on a special push-button located on each tube.

These destroyers are armed with Whitehead A 290 or anti-submarine torpedoes.

The Whitehead B-515 torpedo launching system consists of three 324 mm tubes for Whitehead A-244 or Alliant Techsystems Mk 46 torpedoes (Jane's/David Miller)

Specifications
Length: 3.4 m (11.15 ft)
Width: 1.2 m (3.93 ft)
Height: 1.29 m (4.23 ft)
Weight: 1,050 kg (2,315 lb)

Manufacturers/Contractors
Eurotorp, Sophia Antipolis, France.
Whitehead Motofides, Livorno, Italy.

GUNS

OTOBREDA 127 mm/54 Compatto
There is one OTOBREDA 127 mm/54 Compatto mounting in 'A' position. This weapon is designed to provide naval gunfire support, to engage surface targets and to engage air targets, including anti-ship missiles and fixed-wing aircraft which do not have standoff weapons. The turret is unmanned and is enclosed by a glassfibre shield. Much of the turret and the lower part of the mounting are made of aluminium alloy. The below-deck element of the mounting consists of three drums, each containing 22 rounds, which are stocked automatically from two chain-driven lower hoists which lead to the magazines and are loaded manually. The gun captain uses his control to select which drums are to be replenished and with what ammunition. Japanese versions are reported to have an improved console with more modern electronics including BITE facilities. The weapon is compatible with all US 5 in L/54 ammunition.

Specifications
Gun
Calibre: 127 mm
Length of barrel: 54 calibres
Muzzle velocity: 808 m/s (2,625 ft/s)
Range:
anti-air: 13,600 m (45,000 ft)
anti-surface: 8.6 n miles (16 km) surface/surface
Rate of fire: 45 rds/min
Weight of shell: 32 kg (70 lb)

Mounting
Compatto
Training: 330° at 40°/s
Elevation: −15 to +85° at 30°/s
Crew: 5

Manufacturer/Contractor
OTOBREDA, La Spezia, Italy.

OTOBREDA 76 mm (3 in)/62 Super Rapid
There are three OTOBREDA 76 mm/62 Super Rapid mountings; two are forward abreast the Aspide magazine and the third is aft, atop the hangar roof, with an exceptionally clear field of fire. The three Super Rapid 76 mm guns are used as a combined medium-range anti-surface armament and CIWS against missiles.

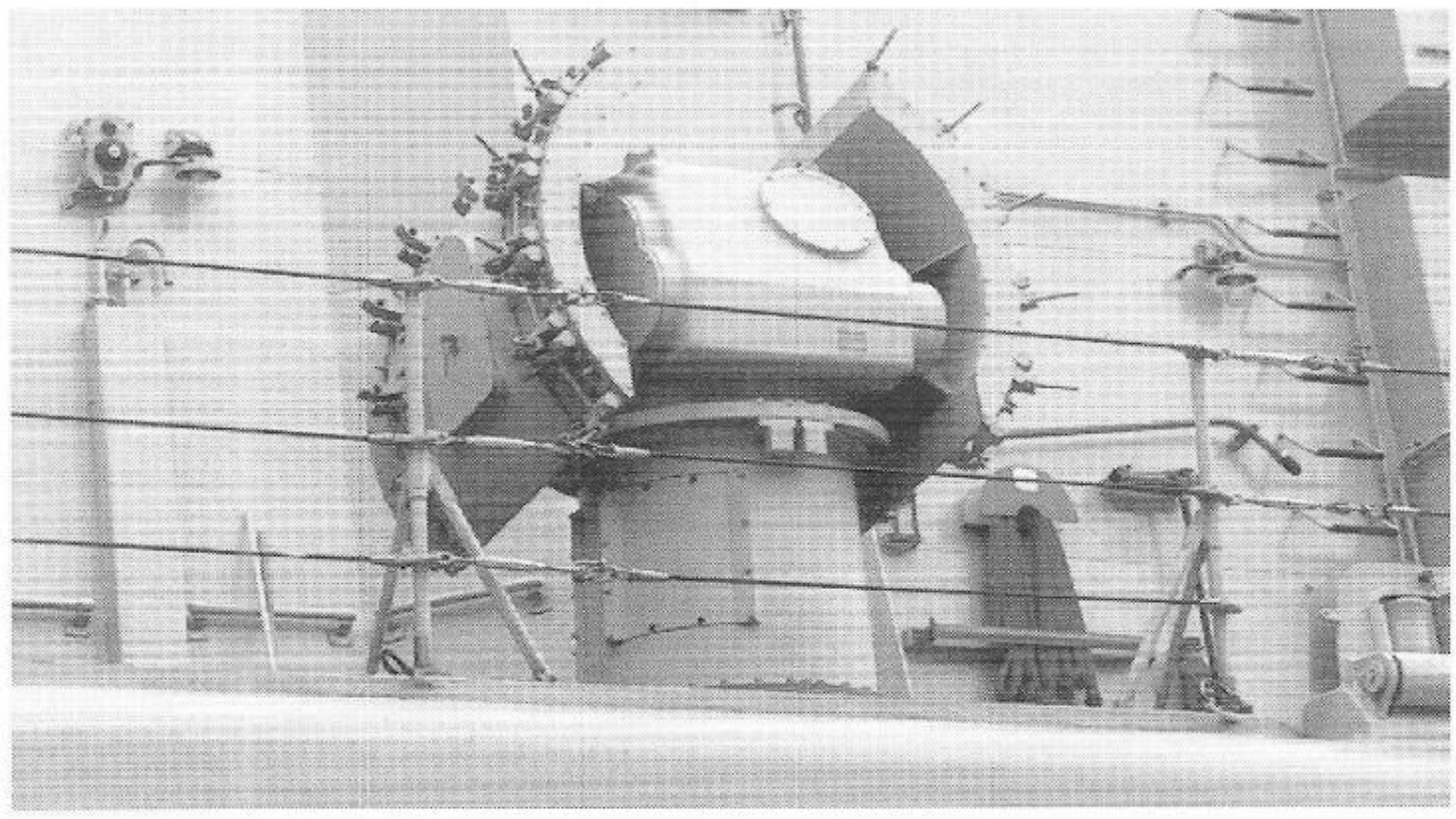
Specifications
Calibre: 76.2 mm (3.0 in)
Length of barrel: 62 calibres (4.72 m; 15.49 ft)
Traverse: 360° at 60°/s
Elevation: −15 to +85° at 35°/s
Muzzle velocity: 925 m/s (3,035 ft/s)
Max rate of fire: 120 rds/min
Range: 8.5 n miles (15.74 km)

Manufacturer/Contractor
OTOBREDA, La Spezia, Italy.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES (ECM)

Nettuno radar detection and countermeasures system
SLQ-732 Nettuno, an integrated radar ESM/ECM system is claimed to have achieve 100 per cent intercept of emitters, using passive surveillance based on environmental synthesis. A very high level of automation ensures immediate and automatic identification based on a powerful threat library, and accurate tracking of emitters. Computer-controlled processing employs structured modular software using a high-level language. There is full, interactive integration with the command and control systems, and also with the flare/chaff launcher systems. Roll-stabilised, multibeam DF antennas provide high-bearing accuracy and feature high-sensitivity, wide dynamic range logarithmic amplifiers and completely digital processing. The ECM section provides self-protection by environment adaptive instant-by-instant automatic jamming, even against simultaneous multiple threats. However, command and control, or the operator, can override the system if



The Sagaie installation aboard De La Penne (Jane's/David Miller)

Franceso Mimbelli *(D 561). Note the large rectangular antenna of the SPS-52 radar, with the two SPG-51D directors below it, and the 76 mm gun on the hangar roof. The recess in the transom holds the 'fish' for the DE1164 VDS while the central of the three hawses on the port side is for the SLQ-25 Nixie decoy* (Jane's/H M Steele)

necessary. The high-power jammer antennas are roll-stabilised and consist of linear arrays that electronically steer a precise and narrow high-gain beam. Jamming implementation follows automatic instructions provided by the ESM section and by the power management computer. High ERP is achieved by using a transmitter design employing paralleled matched high-power Elettronica-designed TWTs.

Manufacturer/Contractor
Elettronica SpA, Rome, Italy.

SLC 705
An equipment designated SLC-705 is fitted, but its purpose is unknown.

DECOYS

CSEE Sagaie
SAGAIE *(Système d'Autodéfense pour la Guerre Infrarouge et Electromagnetique)* is a fully automatic, passive countermeasures system providing protection against incoming missiles guided by electromagnetic (EM) or infra-red (IR) seekers, or any combination of these two, even when the missiles are attacking simultaneously over the entire horizon. SAGAIE is fully automatic from the reception of a missile threat alarm originating from any of the surveillance systems (radar, IR, optical or ESM) and optimises the use of decoys in a very short reaction time. The equipment can be used alone (confusion and distraction) or jointly with a jammer (dilution, substitution after concealment, substitution after deception) by firing substitution decoys. The two fully stabilised launchers are loaded with 10 rockets in 30 kg containers and trainable in azimuth and elevation; two servo units; two aiming and maintenance units; and a processing unit which computes the rocket launching sequence and provides information for the supervision unit; a supervision unit with controls and status displays; and an interface unit which provides for operation with any tactical data or target designation system. SAGAIE fires either EM or IR decoy rocket-type ammunition or both.

Specifications
Range:
chaff: 4.3 n miles (8 km)
IR flares: 1.6 n miles (3 km)

Manufacturer/Contractor
CS Défense, Courtaboeuf, France.

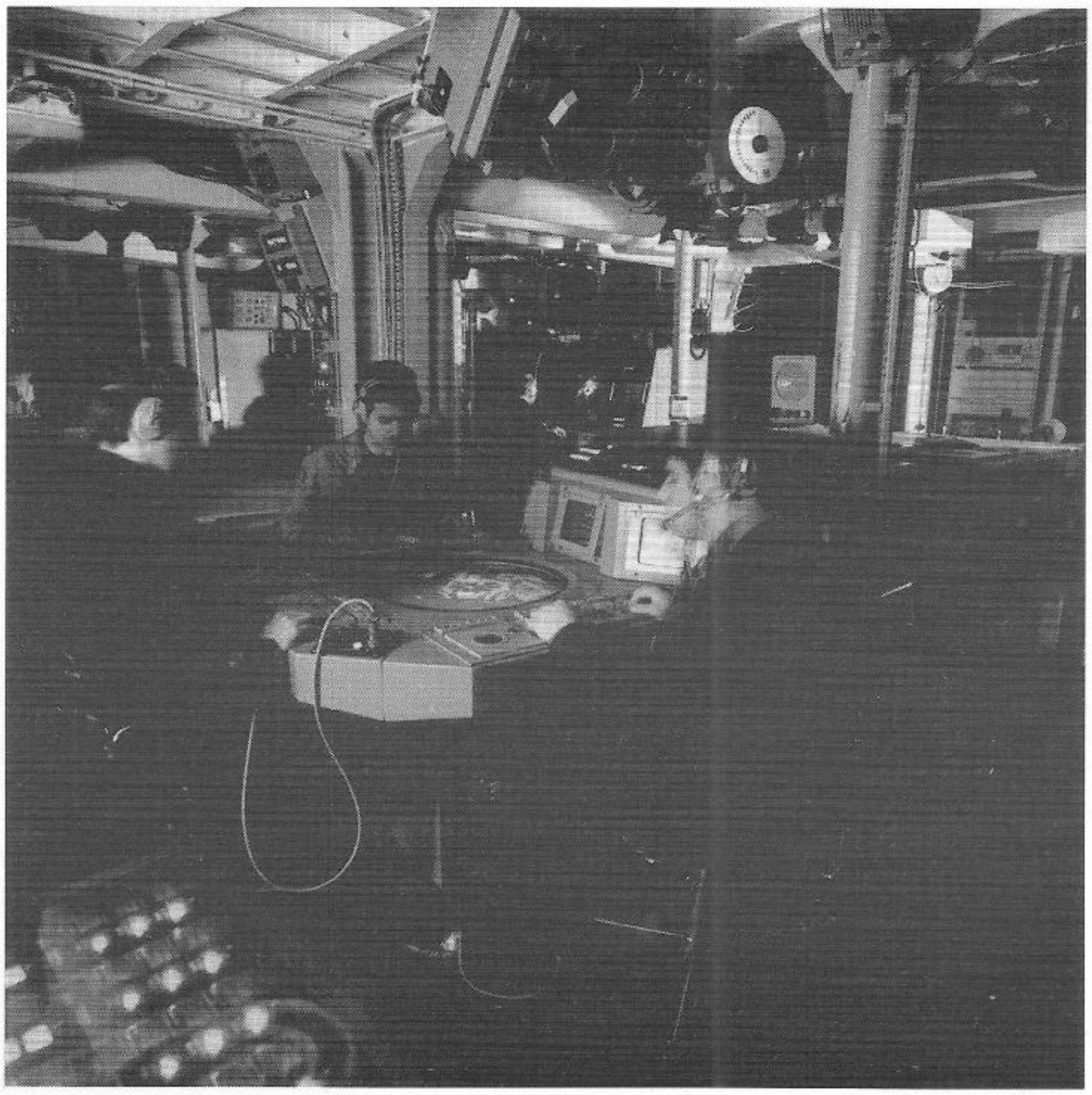
AN/SLQ-25 Nixie noisemaker
One AN/SLQ-25 Nixie (Phase 1), solid-state, modular design electroacoustic countermeasures decoy system is used to protect the ship from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 488 m (1,600 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 95 cm long (3.16 ft), 15.24 cm (6 in) in diameter and weigh 18 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body at a time is deployed.

Manufacturer/Contractor
Aerojet ElectroSystems, Sacramento, California, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

SADOC 2/IPN 20
SADOC 2/IPN 20 *(SADOC = Systema Direzione della Operazioni di Combattimento)* is designed to produce an up-to-date picture of the tactical situation within the vicinity of both the ship and task group, and uses a mainframe architecture to acquire, process and present data acquired by sensors. It is also used for threat evaluation, weapons control, ECM management, aircraft control, conducting ASW operations, and datalink databank management. Data are received from onboard sensors and also from offboard sensors via Link 11, 14 or 16. In addition, track information is exchanged with NADGE (NATO Air Defence Ground Environment) sector operational centres via a Link 11/Link 1 Ship-Shore-Ship Buffer, which also enables the ship to direct shore-based aircraft allocated to its control. There is a 10 Mbit/s serial databus. The basic software of the latter is under the control of two TAVITAC operating systems; the disk operating system and a time-sharing executive. The CPUs are supported by a Tape Cassette Unit (TCU) with three transporters to provide initial programme loading by means of cartridge cassette magnetic tape. They are also used for data recording and retrieval. Input/output (I/O) expander and converter units interface with external systems and an I/O terminal to monitor the system and to provide offline hard copy records. The system is also associated with radar tracking units (RTU) for radar video extraction and automatic tracking and radar central units (RCU) for distributing radar data.



An Italian Navy IPN system

Manufacturer/Contractor
Alenia Elsag Sistemi Navali, Rome, Italy.

COMMUNICATIONS AND DATALINKS

Datalinks: Links 11 and 14
Satcom: NATO, Meteosat, SPS
IFF: X/XII
Tacan: SRN-15A

WEAPONS CONTROL

Dardo E weapon control system
There are four Dardo E automatic CIWS, a system with manual override which is designed to engage sea-skimming and diving missiles as well as manned aircraft. It is a digital system, using a mainframe computer and the Orion RTN 20X radar. Three channels are for Aspide, the others for a single 76 mm gun mounting. The software is written in Assembler language and, in addition to input from the sensors, there are inputs from the gyrocompass, inertial reference, the log and the wind reference unit. Initial target acquisition is by the ship's search radar which interfaces directly with the system which is also linked to the tactical data handling system. Once the RTN 20 radar has acquired the target/targets, the system tracks them automatically, assigning priorities where necessary, although the operator can override the system to engage lower priority targets, if necessary. Targets can be engaged at distances of 300-3,500 m and up to 10 may be tracked simultaneously.

SONAR

Raytheon DE 1164
The 'De La Penne' class is fitted with the Raytheon DE 1164 LF (low-frequency) sonar, with integrated bow (DE 1160) and VDS (DE 1163) systems. The system works at medium frequencies (3.75 kHz (hull); 7.5 kHz (VDS)).

Specifications
Modes: Active and passive (both fully digital)
Frequencies: 3.75 kHz (hull); 7.5 kHz (VDS)
Peak power: 36 kW

Manufacturer/Contractor
Raytheon Company, Portsmouth, Rhode Island, USA.

RADARS

Set	SPS-52C	SPS-768 (RAN-3L)	SPS-774 (RAN-10S)	SPS-702	SPN-748	Four SPG-76 (RTN-30X)	Two SPG-51C
Company	Hughes	Selenia	Selenia	SMA	SMA	Selenia	Raytheon
Role	Long-range air search	Air search	Air/surface search	Surface search,	Navigation	Fire control (Dardo)	Fire control (SAM)
Band	E/F	D	E/F	I	I	I/J	G/I
Range	240 n miles (440 km)	120 n miles (220 km)	85 n miles (155 km)	—	40 n miles (73 km)	22 n miles (40 km)	—
Beam	1.1 × 2.25°	2.15 × 9° plus csc²	1.5 × 17°	0.6°	—	—	Track: 1.6° Illum: 0.9°
Peak power	1,000 kW	135 kW	140 kW	Tac: 180 kW Nav: 50 kW	—	12 kW	Track: 81 kW Illum: 5 kW
Gain	39.5 dB	30 dB	28 dB	—	—	—	Track: 39.5 dB Illum: 45 dB
Pulsewidth	2.5/4.6/10 µs	78.4 (1.6) µs	0.4 µs	Tac: 0.3/1.0,1.6 µs Nav: 1.1 µs	—	0.5/6.5 µs	Track: 2.1-3.2 µs
PRF	1,850/925 pps	—	900 pps	Tac: 8 modes Nav: 1,000/1,028 pps	—	—	Surface: 4.1 kHz Air: 9.5-16.7 kHz
Scan rate	15/6 rpm	6 rpm	15/30 rpm	15 rpm	—	—	—

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 24 × 13 m (78.7 × 42.7 ft)
Hangar: 18.5 m (60.7 ft) long; varying height

HELICOPTERS

These ships normally operate two AB 212ASW, but can also accommodate either one SH-3D Sea King or one EH 101.

Agusta-Bell AB 212ASW

Specifications
Main rotor diameter: 14.63 m (48.0 ft)
Height to rotor head: 3.91 m (12.82 ft)
Rotor disc area: 168.1 m² (1,809 sq ft)
Max take-off weight: 5,070 kg (11,177 lb)
Max speed (never exceed): 130 kts (240 km/h)
Typical cruising speed: 100 kts (185 km/h)
Hovering ceiling (out of ground effect): 396 m (1,300 ft)
Range with max standard fuel: 332 n miles (615 km)
Engine: 1 Pratt & Whitney Canada PT6T-6 Turbo Twin-Pac rated at 1,398 kW (1,875 shp)
Role equipment: AS-12 ASMs or Elettronica Gufo 2000 EW intercept equipment

The AB 212ASW is the Italian Navy's standard ASW helicopter for destroyers and frigates and has been widely exported. It is one of very few shipboard helicopters to use a skid undercarriage (Italian Navy)

PROPULSION

Specifications
System: Combined diesel or gas turbine (CODOG)
Main machinery: 2 Fiat/GE LM2500 gas turbines; 40.3 MW (54,000 hp) sustained; 2 GMT BL 230.20 DVM diesels; 9.3 MW (12,600 hp (m)) sustained;
Shafts: *2*
Propellers: cp

FURTHER INFORMATION

PROGRAMME

Following the success of the 'Audace' class, two further ships of an improved design were approved to replace the elderly 'Impetuso' class destroyers. The order for the two new ships was placed on 9 March 1986 with Riva Trigoso, which, as is the company's normal practice, built the hulls at Riva Trigoso and then fitted them out at Muggiano.

The two ships were originally to have been named Animoso and Ardimento, but these were changed on 10 June 1992 to honour two naval heroes.

Acceptance dates of the two ships were delayed by reduction gear radiated noise problems, but these have since been resolved.

DESIGN

The design is essentially an improved 'Audace' class, but with a longer and beamier hull, which is fully stabilised. Armament is heavy for this type and size of ship; air defence; long range; Standard SM-1MR; short range; Aspide; air/surface; one 127 mm gun; three 76 mm guns; ASW; Milas missile system; AB-212ASW helicopter; 2 × 3 324 mm torpedo launchers

With the exception of the Standard SM-1MR missiles, all of these systems are either of Italian design and manufacture, are manufactured in Italy under licence or are international programmes in which Italy is a partner.

The sensor fit is also comprehensive and is virtually all of Italian origin.

Steel alloys are used for the superstructure and vulnerable areas are protected by Kevlar armour.

Francesco Mimbelli *(D 561)*

JAPANESE DESTROYERS

INTRODUCTION

The Japanese Maritime Self-Defense Force (JMSDF) has the second largest destroyer force after the US Navy. Its current fleet of 39 destroyers is thoroughly up to date and some of them — in particular, the 'Kongo' and 'Murusame' classes — are among the most powerful units of their type afloat. The composition of that force looks complicated at first, but is, in fact, composed of just three major types which have been the subject of a well conceived plan.

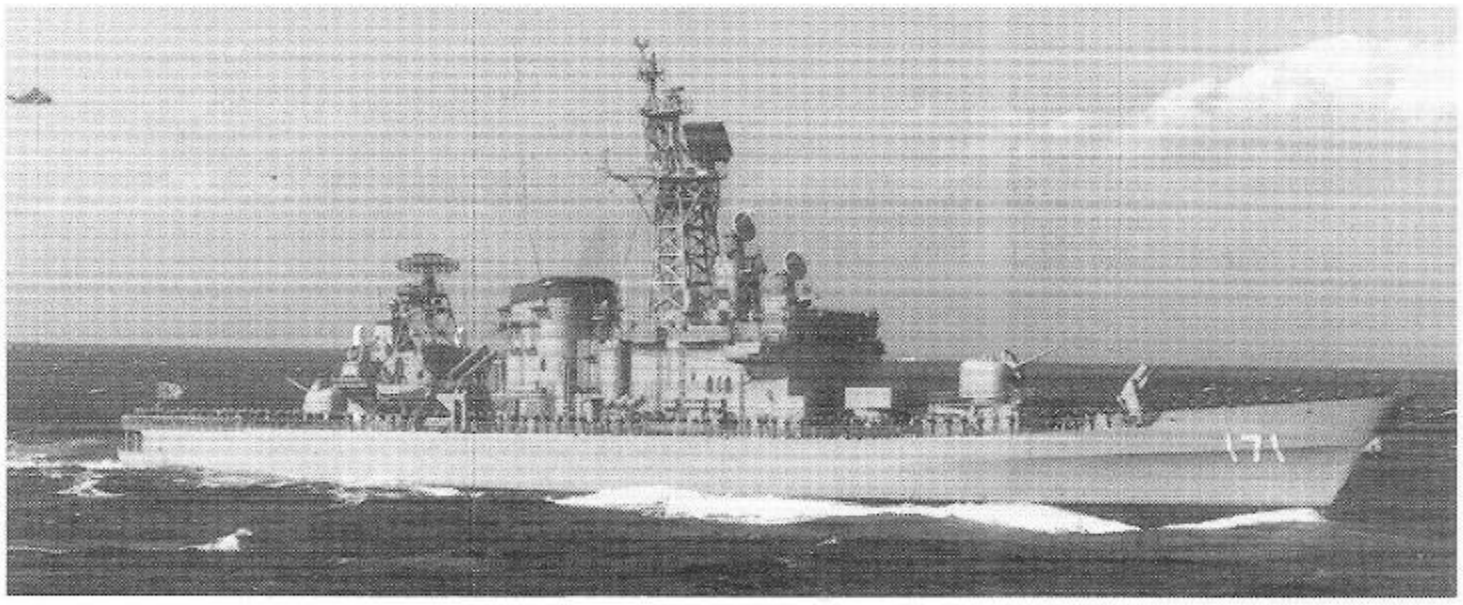
The development of Japanese destroyers must be seen in the context of the national defence plans which require the Maritime Self-Defense Force (MSDF) to maintain a force of four, well-balanced, 'escort flotillas', as explained in a recent defence white paper:

> "The most important unit for the MSDF is the escort flotilla. The Outline (that is, the overall national defence plan) stipulates that the MSDF 'must possess one fleet escort force as a mobile operating ship unit in order to quickly respond to aggressive action and such situations at sea.' The fleet escort force must be able to maintain one escort flotilla on alert at all times..... 'the MSDF needs four escort flotillas in order to maintain to keep (sic) at least one escort flotilla on alert at all times.' (Defense of Japan, Defense Agency, Tokyo, 1992)

Meeting this national requirement has resulted in the development of three types of major warship:

- a general purpose destroyer, with priority given to the anti-submarine mission
- a hybrid destroyer/helicopter carrier
- an air defence destroyer.

Destroyer Kongo *(DDG 173), lead ship of a class of four and among the most powerful surface warships in any navy. The 'Kongo' class is armed with a total of 90 Standard SM-2MR and ASROC missiles, plus eight Harpoon SSMs, a 127 mm (5 in) gun and two CIWS. At the heart of its capability is the Aegis command system which enables the commander to fight his ship more effectively than any previous warship* (Hachiro Nakai)



The JMSDF has produced a cohesive surface fleet composed primarily of a large number of destroyers, which are among the most capable warships in any navy. Destroyer development has followed three clear strands. First is the air defence destroyer typified by Hatakaze *(DD 171) (above left) nameship of a class of two, armed with Standard SM-1 MR missiles for its primary role, but also carrying Harpoon, ASROC, two 127 mm (5 in) guns and a CIWS. Second, is the general purpose destroyer such as the 'Hatsuyuki' class* Yamayuki *(DD 129) (above right) which is armed with one 127 mm (5 in) gun, ASROC, Harpoon, two CIWS and Sea Sparrow short-range SAM. It also has a large flight deck and hangar for an SH-60J Seahawk ASW helicopter. The third element is composed of four hybrid destroyer/helicopter carriers, such as* Kurama *(DDH 144) (below left) which, in addition to a heavy armament, have a flight deck and hangar which enable them to carry three ASW helicopters* (Hatakaze — Hachiro Nakai; Yamayuki — Jane's/H M Steele; Kurama — H and L van Ginderen Collection)

These ships are grouped into four escort flotillas which are based on the mainland of Japan: at Yokosuka on the east coast, Sasebo in the south, and Maizuru and Kure on the west coast. Each flotilla has a destroyer/helicopter carrier as flagship, and two, three or four divisions of two or three destroyers each. There is also one destroyer, actually the oldest in the front line, which serves as the fleet flagship.

General

All destroyers, of whatever type, are armed with ASROC and two triple 324 mm torpedo tubes. In addition, all except the helicopter carriers carry Harpoon anti-ship missiles or, in the case of the latest 'Murasame' class, the Japanese equivalent, the SSM-1B.

All the destroyers are armed with at least one gun. The most recent General Purpose classes have one OTOBREDA 76 mm gun, while the 'Takatsuki' class has one 127 mm gun, and two older classes have either one or two US Navy Mk 33 76 mm (3 in) mountings. The air defense destroyers have 127 mm guns, two each of the US Navy Mk 42, except for the latest 'Kongo' class, which has one OTOBREDA 127 mm Compatto.

General purpose destroyers

Apart from the older ships, the modern general purpose destroyers are armed with eight Harpoons in individual canister launchers, Sea Sparrow short-range SAMs and ASROC anti-submarine missiles in either Mk 112 octuple launchers or in Mk 41 vertical launchers.

Helicopter carriers

There are two pairs of hybrid destroyer/helicopter carriers which combine a large hangar and flight deck aft, with a conventional destroyer forepart, an arrangement reminiscent of the 'Moskva,' 'Vittorio Veneto' and 'Tiger' classes in European navies. All can carry three helicopters, either HSS-2B (SH-3) or SH-60J. Two of the ships were completed in 1973-74 and the other two in 1980-81, and the former will need replacement soon. No announcement of possible replacements has yet been made and it will be of considerable interest to see whether the JMSDF opts for another hybrid design, or for a more specialised helicopter carrier.

Anti-submarine warfare

One of the main threats facing the JMSDF is operations by hostile submarines against Japanese or allied naval and merchant shipping. Great attention is, therefore, paid to anti-submarine warfare in the design and weapons and sensor fits of its ships. This is also an area where the American influence has been strong and the JMSDF followed the US lead, first on DASH helicopters and then on ASROC. The JMSDF's helicopters have always been of US origin, with concentration on, first, the SH-3, and currently on the SH-60J.

Propulsion

In propulsion, the JMSDF has followed the trend in major navies with a swing from steam turbines and diesels to all gas turbine systems. In the 1980s, most newbuild JMSDF destroyers were powered by Rolls-Royce gas turbines, but General Electric broke into the market with the provision of engines for the 'Kongo' class. The latest 'Murusame' class, however, achieves a unique combination of two Rolls-Royce Speys with two General Electric LM-2500.

Sensors

Originally, all sensors were of US origin, but there was then a swing towards Japanese licensed production of US designs. There is some indication now, however, that Japan, which after all, possesses one of the world's most advanced electronic industries, is developing its own equipment, a trend that seems likely to continue.

TABLE 1: JAPANESE DESTROYER TYPES IN SERVICE IN 1997

		Number built (on order)	Entered service	Displacement (full load) t	Number in service 1 Jan 1997
General purpose Anti-Submarine (DD)	Minegumo	3	1968-1970	2,750	3
	Takatsuki	4	1967-1970	4,500	3
	Hatsuyuki	12	1982-1987	3,800	12
	Asagiri	8	1988-1990	4,200	8
	Murasame	1 (+5)	1996-2000	5,100	1
Helicopter carriers (DDH)	Haruna	2	1973-1974	6,300	2
	Shirane	2	1980-1981	6,800	2
Air defense guided missiles (DDG)	Tachikaze	3	1976-1982	4,800	3
	Hatakaze	2	1986-1988	5,500	2
	Kongo	4 (+1)	1993-2000	9,485	3
	TOTALS	41 (+6)			39

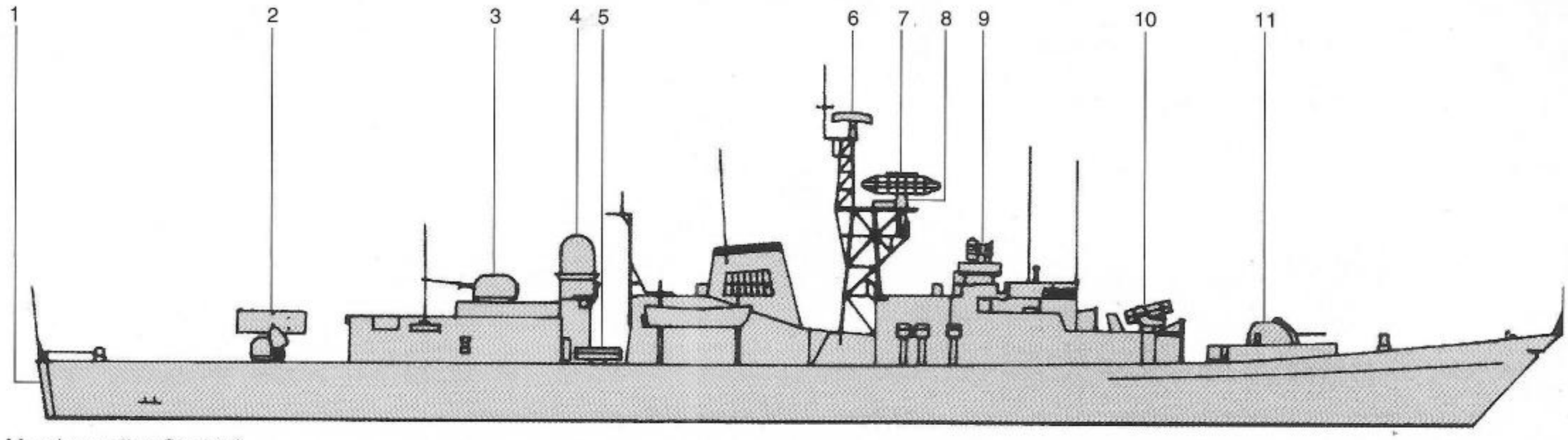
TABLE 2: JAPANESE HELICOPTER CARRIER AND AIR DEFENCE DESTROYER ARMAMENT

		Air defence ships (DDG)			Helicopter carriers	
		Tachikaze	Hatakaze	Kongo	Shirane	Haruna
Missiles	Harpoon	8	8	8	–	–
	Standard SM-1MR	Mk 13	Mk 13		–	–
	Standard SM-2MR	–	–	2 × Mk 41 VLS	–	–
	Sea Sparrow	–	–	–	Mk 29	Mk 29
	ASROC	Mk 112	Mk 112	Included in VLS	Mk 112	Mk 112
Guns	FMC 127 mm Mk 42	2 × 1	2 × 1	–	2 × 1	2 × 1
	OTOBREDA 127 mm	–	–	1 × 1	–	–
	US Navy 76 mm	–	–	–	–	–
	OTOBREDA 76 mm	–	–	–	–	–
	Vulcan Phalanx CIWS	2	2	2	2	2
ASW	Mk 32 TT	2 × 3	2 × 3	2 × 3	2 × 3	2 × 3
	Bofors 375 mm RL	–	–	–	–	–
Helicopter	SH-60J	–	–	–	3	3
Propulsion		steam turbines	COGAG	COGAG	steam turbines	steam turbines

TABLE 3: JAPANESE GENERAL PURPOSE/ASW DESTROYER ARMAMENT

		Minegumo	Takatsuki	Hatsuyuki	Asagiri	Murasame
Missiles	Harpoon	—	8	8	8	8
	Sea Sparrow	—	Mk 29	Type 3	Mk 29	Mk 48 VLS
	ASROC	Mk 112	Mk 112	Mk 112	Mk 112	Mk 41 VLS
Guns	127 mm	—	2 × 1	—	—	—
	76 mm	1 × twin	—	—	—	—
	OTOBREDA 76 mm	1	—	1	1 × 1	1 × 1
	CIWS	—	1	2	2	2
ASW	Mk 32 TT	2 × 3	2 × 3	2 × 3	2 × 3	2 × 3
	Bofors 375 mm RL	1	—	—	—	—
Helicopter	SH-60J	—	—	1 × SH-60J	1 × SH-60J	1 × SH-60J
Propulsion		4 diesels	steam turbines	COGOG	COGAG	COGAG

MINEGUMO



Murakumo (Ian Sturton)
1 *EDO S25-36(J) VDS* **2** *Mk 112 ASROC eight-cell launcher* **3** *OTOBREDA Mk75 76 mm (3 in)/62 single gun mounting* **4** *GFCS 2-12B gunfire control system* **5** *Mk 32 324 mm triple torpedo launcher (two)* **6** *JRC OPS-17 radar (surface search)* **7** *MELCO DPS-11 radar (air search)* **8** *NEC NOLR-5 radar intercept system* **9** *GFCS-1B gunfire control system (for twin 76 mm (3in) mount)* **10** *Bofors Type 71 375 mm four-barrelled ASW mortar* **11** *Mk 33 US Navy 76 mm (3 in) twin mount*

GENERAL SPECIFICATIONS

Operator: Japan

Class: MINEGUMO

Built: 3
Active: 1

Displacement:
standard: 2,150 t
full load: 2,750 t

Dimensions
Length: 115 m (377.2 ft)
Beam: 11.8 m (38.7 ft)
Draught: 4 m (13.1 ft)

Speed: 27 kts
Range: 7,000 n miles at 20 kts

Complement: 220 (19 officers)

SHIPS

MURAKUMO (DD 118)
Builder Hitachi, Maizuru, Japan
Laid down 19 Oct 1968
Launched 15 Nov 1969
Commissioned 21 Aug 1970

WEAPONS SYSTEMS

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

The 'Minegumo' class has a single Mk 112 ASROC launcher on the quarterdeck, with a magazine immediately beneath it. ASROC is a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 1,500 ft (460 m).

When a submarine target is detected it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (200 ft/1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (2,000 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and as they separate the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Murakumo *(DD 118) is the last survivor of a class of three ships and is used as the flagship of the escort force.* Murakumo *was fitted with an OTOBREDA 76 mm (3 in) gun as a trial, which was presumably judged a success as there have been numerous subsequent installations* (Hachiro Nakai)

Specifications

ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid monopropellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor

Honeywell Training and Control Systems, West Covina, California, USA.

TUBES

Two triple 324 mm Type 68 torpedo tubes are sited amidships, one on either beam. This is a US Mk 32 installation, manufactured under licence in Japan.

Specifications

Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

Natsugumo *(DD 117) is now a training ship but illustrates the features of* Murakumo. *Of particular note are the US Navy twin 76 mm (3 in) mount and the Bofors 375 mm ASW mortar before the bridge; both types of weapon were widely fitted in JMSDF destroyers and frigates built in the 1960s* (Hachiro Nakai)

TORPEDOES

Alliant Techsystems Mk 46 Mod 5 (Neartip) 324 mm torpedoes

Specifications
Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507.0 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

GUNS

Mk 33 76 mm (3 in) L/50 gun mounting
As built, the Minegumo had two Mk 33 mountings, but one has been removed leaving one in 'A' position. The Mk 33 is a twin-gun, power-driven, base-ring mount with local or remote control. The automatic loading mechanism is above each Mk 22 gun and is fed manually from either side, with motor-driven sprockets moving the shell into the centre of the loader from where they are dropped onto a transfer tray, which pushes them into the breech for ramming. In Japanese service the mounting operates with the GFCS-1B fire-control system.

Specifications
Gun
Calibre: 76.2 mm
Length of barrel: 50 calibres (4.05 m)
Muzzle velocity: 823 m/s (new gun, nominal); 808 m/s (mid-life)
Range: 7 n miles (13 km)
Altitude: 8,951 m
Weights:
complete round: 10.9 kg
projectile: 5.9 kg
Barrel life: 4,300 EFC (Equivalent Full Charges)

Mk 33 mounting
Traverse: 360° at 30°/s
Elevation: −14/15° to +85° at 24°/s
Rate of fire: 50 rds/min/barrel)

FMC/OTOBREDA 76 mm (3 in)/62 Mk 75 Compact
There is one OTOBREDA 76 mm (3 in) gun sited aft on the roof of the former hangar.

Specifications
Calibre: 76.2 mm (3.0 in)
Length of barrel: 62 calibres (4.72 m; 15.49 ft)
Traverse: 360° at 70°/s
Elevation: −15 to +85° at 40°/s
Muzzle velocity: 900 m/s (2,953 ft/s)
Max rate of fire: 85 rds/min
Range: 8.6 n miles (16 km)

Manufacturer/Contractor
OTOBREDA, La Spezia, Italy.

ASW MORTAR

Mitsubishi (Bofors) Type 71 375 mm ASW rocket system
There is a single, four-tube Type 71 ASW rocket launcher located in the 'B' gun position. This is the Bofors 375 mm rocket system, produced in Japan under licence by Mitsubishi Heavy Industries. The system consists of a rocket launcher, a handling system, the ship sonar and a fire-control system.

The four launch tubes are mounted on trunnions with an automatic contact device to connect the rockets with the fire-control system. The hydraulic laying machinery is in the front of the mounting and a flame deflector in the rear. Each system features an automatic electrohydraulic handling system. The rounds are stored vertically beneath the mounting and selected by an operator. A grab on a roof-mounted rail picks up the round by the nose and transfers it to the loading table. A hoist brings this through the deck hatch to where the launch tubes have been elevated to their loading position. The rounds are then inserted through the rear of the launch tube.

The magazine holds 48 rounds and reload time is three minutes, each tube being loaded separately. The rate of fire is one round a second and rockets may be fired singly or in salvos. There are two types of rocket, both with Hexotonal filling. The Type E (Erika) rocket has Stidar time and impact fuzes, while the Type N (Nelli) uses the Zambo proximity and impact fuzes.

Specifications
Launcher
Tubes: 4
Traverse: 260° at 18°/s
Elevation: −15 to +90° at 18°/s
Crew: 4

Rockets

	Type E	Type N
Weight	250 kg (551 lb)	230 kg (507 lb)
Muzzle velocity	130 m/s (427 ft/s)	205 m/s (673 ft/s)
Explosive weight	107 kg (236 lb)	80 kg (176 lb)
Range	0.35-0.87 n miles (0.65-1.63 km)	0.85-2.11 n miles (1.58-3.62 km)
Sinking speed	10.7 m/s (35.1 ft/s)	9.2 m/s (30.2 ft/s)

Manufacturer/Contractor
Mitsubishi Heavy Industries, Kobe, Japan.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES (ECM)

NEC NOLR-5
NOLR-5 is an early radar intercept set, with only very limited effectiveness against incoming anti-ship missiles.

Manufacturer/Contractor
NEC, Tokyo, Japan.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS AND DATALINKS

IFF: US Mk 10
Satcom (for deployments).

WEAPONS CONTROL

Mitsubishi Model 1B fire-control system
Murakumo is fitted with the Gunfire Control System Model 1B (GFCS-1B), also known as the Type 72.

Manufacturer/Contractor
Mitsubishi Electric Corp (MELCO), Tokyo, Japan.

RADARS

Mitsubishi OPS 11
OPS-11 is a Japanese-designed, long-range, air search radar.

Manufacturer/Contractor
Mitsubishi Electric Corp (MELCO), Tokyo, Japan.

JRC OPS 17
JRC OPS-17 is the surface search radar. It operates in the G/H bands.

Manufacturer/Contractor
JRC, Tokyo, Japan.

Western Electric SPG-34
Murakumo (DD 118) also carries an elderly Western Electric SPG-34, which is associated with the GFCS-1B. It works in the I/J bands and produces a 3 × 3° conical scan beam for target acquisition and a 0.75° conical scan beam for target tracking.

SONARS

NEC OQS 3
OQS-3 is a licence-built, Japanese version of the US Navy's AN/SQS-23 bow-mounted sonar.

NEC SQS-35(J)
Murakumo is fitted with an AN/SQS-35(J) variable depth sonar (VDS), licence-built in Japan by NEC. It is an active/passive search system, operating at medium frequency (13 kHz) and has 24 staves.

PROPULSION

Specifications
Main machinery: 4 Mitsui 1228 V 3BU and 2 Mitsui 1628 V 3BU diesels; 20.72 MW (28,200 hp (m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

Nine ASW ships were built for the JMSDF between 1964 and 1978, comprising a first batch of three 'Yamagumo' class ships, three 'Minegumo' class, and then a second batch of three 'Yamagumo' class. Of the three 'Minegumo' class ships, only one, *Murakumo* (DD 118), remains in front-line service, the other two having been converted for use as training ships.

DESIGN

All nine ships had identical hulls and propulsion systems, and all had ASW as their primary mission. The essential difference between the two classes is that there were two different armament fits, which led to them being treated as two separate classes. The 'Minegumo' class was built around the DASH drone helicopter system, with a flight deck and hangar aft, and had a single stack.

MODERNISATION

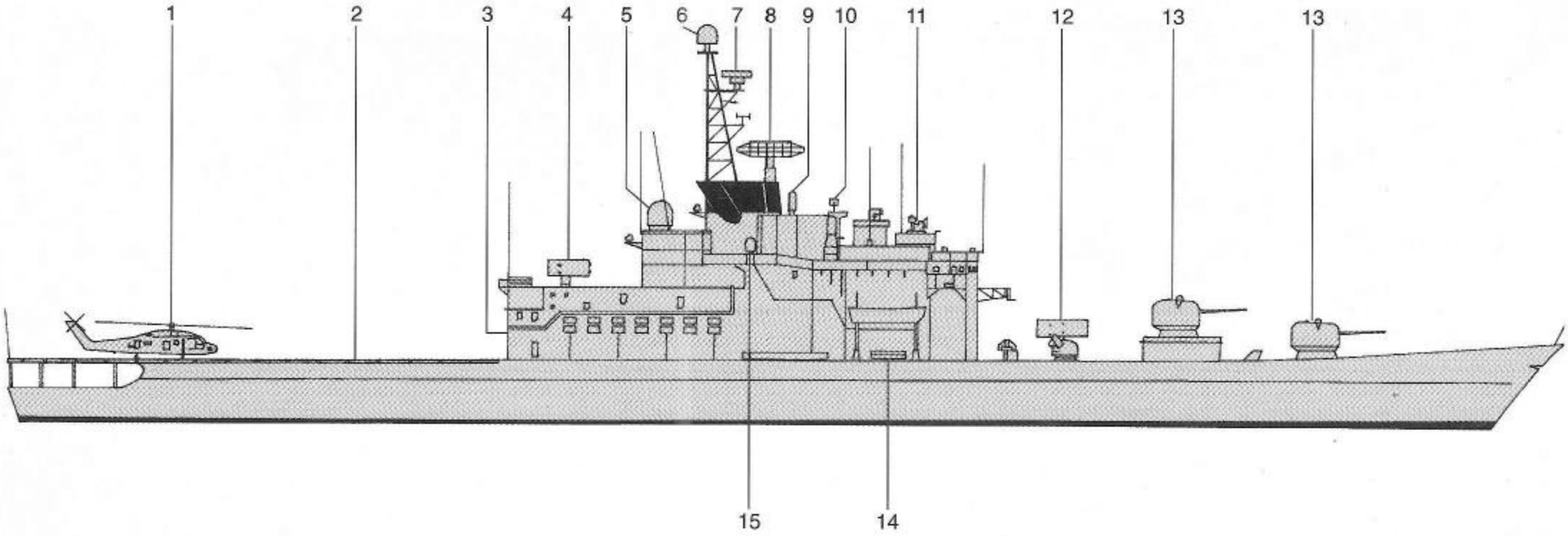
When the failure of the DASH system was finally accepted, it was replaced by ASROC, but the single stack prevented an identical installation to that in the 'Yamagumo' class. So, the Mk 112 launcher was mounted on the former flight deck.

In 1978 the after US Navy Mk 33 mounting was removed from *Murakumo* (DD 118) and was replaced by an OTOBREDA 76 mm mounting.

DEPLOYMENT

Murakumo (DD 118) is employed as flagship of the Escort Force and is based at Yokosuka. It may be assumed that the ship is fitted with additional communications and command facilities to fit it for the flag role.

HARUNA



Haruna (Ian Sturton)
1 *SH-60J Seahawk ASW helicopter* **2** *Flight deck* **3** *Hangar* **4** *Mk 29 eight-cell launcher for Sea Sparrow SAM* **5** *Type 2-12 fire control (for Sea Sparrow SAM)* **6** *OLR-9 ESM intercept antenna* **7** *JRC OPS-28 radar (surface search)* **8** *MELCO OPS-11C radar (air search)* **9** *NOLQ-1 jammer* **10** *Mk 15 Vulcan Phalanx CIWS* **11** *Type 1A fire control (for 127 mm (5 in) guns)* **12** *Mk 112 ASROC eight-cell launcher* **13** *127 mm (5 in)/54 Mk 42 single gun mountings* **14** *Type 68 324 mm triple torpedo launchers* **15** *Satcom*

GENERAL SPECIFICATIONS

Operator: Japan

Class: HARUNA

Built: 2
Active: 2

Displacement:
standard: *Haruna* (DD 141)—4,950 t; *Hiei* (DD 142)—5,500 t
full load: 6,300 t

Dimensions
Length: 153 m (502 ft)
Beam: 17.5 m (57.4 ft)
Draught: 5.2 m (17.1 ft)

Speed: 31 kts

Complement:
Haruna (DD 141): 370 (36 officers)
Hiei (DD 142): 360 (36 officers)

SHIPS

HARUNA (DD 141)

Builder	Mitsubishi, Nagasaki, Japan
Laid down	19 Mar 1970
Launched	1 Feb 1972
Commissioned	22 Feb 1973

HIEI (DD 142)

Builder	Ishikawajima Harima, Tokyo, Japan
Laid down	8 Mar 1972
Launched	13 Aug 1973
Commissioned	27 Nov 1974

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Raytheon Sea Sparrow point-defence missile system

Both ships are fitted with a Mk 29 octuple launcher for the Sea Sparrow system which is located on the hangar roof. Sixteen RIM-7 Sea Sparrow missiles are carried and the system uses one of the two Mitsubishi Type 2-12B fire-control systems which is housed in a large white radome immediately abaft the mack. The system is fully automatic from target acquisition to interception. The Sea Sparrow missile, although based upon the air-to-air Sparrow, has been enhanced for launching from ships, and has a 38.6 kg blast fragmentation warhead and a dual-purpose proximity impact fuze.

Specifications (RIM-7M)

Length: 3.66 m (12.0 ft)
Diameter: 20.3 cm (8.0 in)
Wing span: 1.02 m (3.35 ft)
Weight: 226.8 kg (500 lb)
Speed: Mach 2.5
Range: 8 n miles (14.5 km)
Warhead (WAU-17/B): 38.6 kg (85.1 lb)
Guidance: Semi-active radar

Manufacturers/Contractors

Raytheon Company, Equipment Division (prime system contractor).
Raytheon Company, Missile Systems Division (prime missile contractor).
Hughes Missile Systems (second missile source).
Naval Weapons Center, Crane, USA (warhead).

TUBES

Two triple 324 mm Type 68 torpedo tubes are sited amidships, underneath the boat davits, one on either beam. The Type 68 is the US Mk 32 design, manufactured under licence in Japan.

Specifications

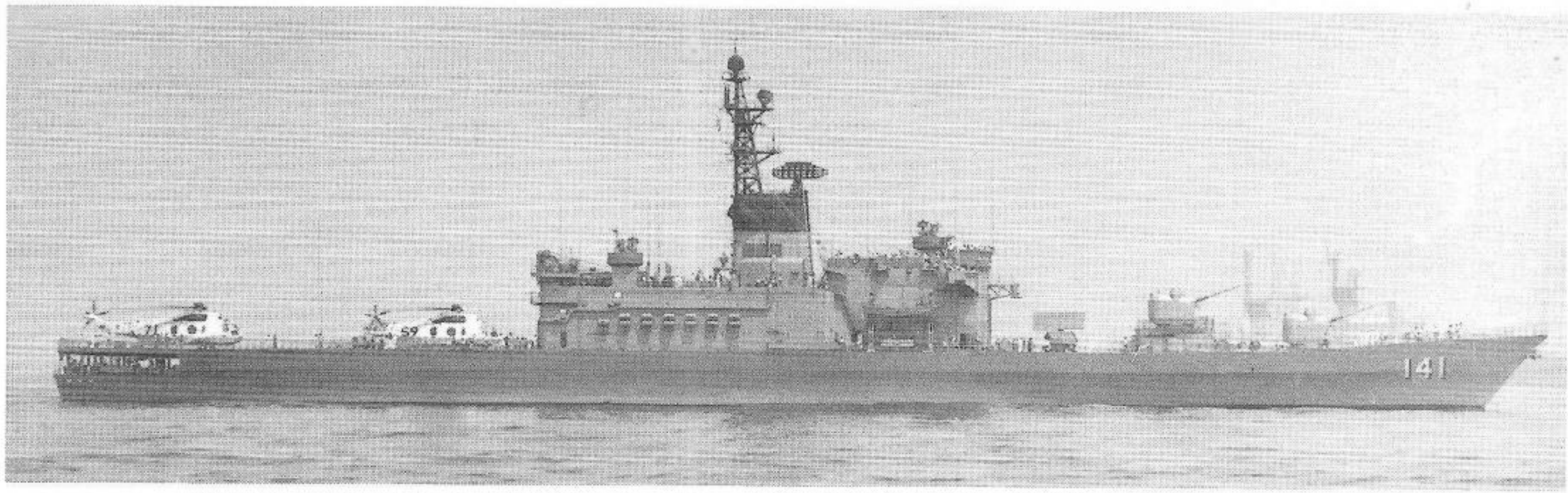
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

ANTI-SUBMARINE MISSILE

Honeywell RUR-5A ASROC

The 'Haruna' class has a single Mk 112 launcher on the foredeck, with a magazine immediately beneath it. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 460 m.

When a submarine target is detected it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (196.8 and 1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (1,968 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and, as they separate, the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.



These two shots of Haruna *(DDH 141) show a variety of differences over the ship's life. In 1980 (top) the bridge roof was relatively clear while the hangar roof had a variety of weapons and sensors. By 1987 (below), however, the hangar roof has been cleared to enable a Mk 29 eight-cell Sea Sparrow launcher to be installed, together with a 16-round magazine. On the other hand, the bridge roof is now covered with new deckhouses and two Vulcan Phalanx CIWS.* (Top — H & L van Ginderen Collection; Below — Hachiro Nakai)

Specifications
ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid monopropellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor
Honeywell Training and Control Systems, West Covina, California.

TORPEDOES

Alliant Techsystems Mk 46 Mod 5 (Neartip) 324 mm torpedoes

Specifications
Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507.0 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

Manufacturer/Contractor
Alliant Techsystems, Mukilteo, Washington, USA.

GUNS

United Defense Mk 42 Single 127 mm (5 in)/54 gun mounting
There are two Mk 42 mountings on the foredeck, each housing a single Mk 18 127 mm/54 gun. The Mk 18 gun has a two-piece barrel with replaceable liner and a service life of some 2,000 rounds. A bayonet-type joint attaches the gun to the housing which includes a vertical sliding breech block and the entire gun assembly is supported on rollers in the slide. A separate rammer is mounted on the slide.

The Mk 42 mounting was introduced in 1953 and was produced in Japan under licence. The upper part of the mounting is fully power-driven and is enclosed in an armoured shield. The Mk 42 mounting requires a crew of 12: four men within the shield and eight in the magazine and ammunition handling system.

Ammunition is loaded by a dual system with projectiles supplied automatically to the slide alternately from the right and left. The loading system consists of two manually loaded drums, one with 20 projectiles and the other with 20 charges, which rotate to bring the projectile and cartridge together. Complete rounds are lifted from the lower hoist to the upper hoist and from there to the cradles which move them to the tray from where they are rammed into the breech.

Magazine capacity is 550 rounds and ammunition includes the Mk 41 AAC/HC, Mk 42 common, and Mk 48 illumination rounds, all of which weigh 31.75 kg. All rounds have point detonating, proximity or mechanical time fuzes.

Specifications
Gun, 127 mm/54 Mk 18
Calibre: 127 mm
Length of barrel: 54 calibres
Muzzle velocity:
new barrel: 807 m/s
mid-life: 792 m/s
Max range: 12 n miles (22 km)
Max altitude: 14,400 m (47,000 ft)
Ammunition: 31.75 kg (70 lb)

Mounting, Mk 42
Traverse: 360° at 40°/s
Elevation: −15 to +85° at 25°/s
Rate of fire: 20-40 rds/min

Manufacturer/Contractor
United Defense Armaments Systems Division, Minneapolis, Minnesota, USA.

Hughes Mk 15 CIWS Phalanx
There are two Hughes Mk 15 Phalanx close in weapons systems (CIWS) situated either side of the mack. The mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications
Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse-Doppler

Manufacturer/Contractor
Hughes Missile Systems, Tucson, Arizona, USA (system).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES (ECM)

NOLQ-1

NOLQ-1 is one of the standard range of JMSDF intercept/jammers.

Manufacturer/Contractor

Mitsubishi Electric Corp (MELCO), Tokyo, Japan.

OLR 9

OLR-9 is an intercept equipment which is reported to be generally similar to AN/WLR-11

Manufacturer/Contractor

Fujitsu, Tokyo, Japan.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher

There are four Mk 36 SRBOC (Super Rapid Bloom Off-board Countermeasures) units.

Specifications

Launcher

Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)

Weight: 173 kg (381.4 lb)

Range: 2.2 n miles (4 km)

Rounds

Diameter: 130 mm (5.1 in)

Length, weight:

Mk 182: 1,209 mm; 22.7 kg

Super Chaffstar: 1,209 mm; 20.9 kg

Super Gemini: 451 mm; 5.5 kg

Super Hiram III: 1,220 mm; 13.6 kg

Super Hiram IV: 467 mm; 3.8 kg

Super Loroc: 734 mm; 13.2 kg

Manufacturers/Contractors

Loral Hycor Inc, Woburn, Maryland, USA.

Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

OYQ-6 action data automation

OYQ-6 is similar to the earlier OYQ-3 but has a Link 11 capability, enabling it to exchange encrypted digital data over HF and UHF links.

COMMUNICATIONS AND DATALINKS

In addition to the normal communications, these ships have:

Links 11 and 14
Satcom
IFF: US Mk 10
Tacan: NEC ORN-6.

WEAPONS CONTROL

GFCS Model 1A

GFCS (Gun Fire-Control System) Model 1A is the control system for the 127 mm (5 in) gun.

FCS Model 2-12B

This is the weapons control system for Sea Sparrow. The associated radar operates in the I/J bands.

RADARS

Mitsubishi OPS-11C

OPS-11C is a Japanese-designed, long-range, air search radar, operating in the B/C/D bands. OPS-11B operates in the B band.

JRC OPS 28C/D

OPS-28 is a surface search and short-range air search radar, operating in the G- and H-bands.

Haruna *(DDH 141) showing a variety of sensors. At the front of the bridge is an OE-2 satellite antenna with (to its left) an unknown radome. To the left of the radome is the Type 1A fire control for the 76 mm guns. The prominent white thimble radome covers the UPS-2 radar of the Vulcan Phalanx (the top of the port CIWS can just be seen on the other side of the superstructure). Behind the starboard CIWS is the rectangular-shaped NOLQ-1 jammer and above it the OPS-11C air search radar. On the hangar roof is the large white radome of the Type 2-12 fire controller for Sea Sparrow and in front of that is a smaller radome for a second type of Satcom system* (Hachiro Nakai)

SONARS

NEC OQS-3

OQS-3 is a licence-built, Japanese version of the US Navy's AN/SQS-23 bow-mounted sonar.

Manufacturer/Contractor

Mitsubishi Electrical Corp (MELCO), Tokyo, Japan.

AVIATION

AVIATION FACILITIES

Specifications

Flight deck: 50 × 17.5 m (164.6 × 57.4 ft)

HELICOPTERS

Mitsubishi-Sikorsky SH-60J Seahawk

The class originally operated three Mitsubishi/Sikorsky HSS-2B Sea Kings but these have now been replaced by SH-60Js.

Specifications

Main rotor:

diameter: 16.36 m (53.66 ft)

disc area: 210.15 m² (2,262 sq ft)

Tail rotor:

diameter: 3.35 m (11.00 ft)

disc area: 8.83 m² (95.03 sq ft)

Length overall:

fuselage: 15.26 m (50.0 ft)

rotors turning: 19.76 m (64.83 ft)

Height overall, tail rotor turning: 5.18 m (17.0 ft)

Weight empty: 6,191 kg (13,648 lb)

Mission gross weight: 9,182 kg (20,244 lb)

Performance

Dash speed at 1,525 m (5,000 ft), tropical day: 126 kts (234 km/h)

Vertical rate of climb at S/L, 32.2°C (90°F): 213 m (700 ft)/min

Power plant: 2 General Electric T700-GE-401 turbo-shafts rated at 1,260 kW (1,690 shp) 1,342 kW (1,800 shp)

Accommodation: 3 (pilot and airborne tactical officer/back-up pilot in cockpit, sensor operator in specially equipped station in cabin)

Radar: Japanese HPS-104 search radar

Flight: Japanese automatic flight management system and ring laser gyro AHRS

Instrumentation: Japanese controls and displays sub-system, datalink and tactical data processor

Mission: Japanese HQS-103 sonar; Texas Instruments AN/ASQ-81D2(V) MAD; Ednac AN/ARR-75 sonobuoy receiver

Self-defence: General Instruments AN/ALR-66 (VE) RWR; Japanese HLR-108 ESM

Armament: 2 Mk 46 torpedoes or depth bombs

PROPULSION

Specifications
System: Steam turbines
Main machinery:
***Haruna* (DD 141):** 2 Mitsubishi boilers; 60 kg/cm² (850 psi); 480°C (900°F); 2 Mitsubishi turbines; 51.5 MW (70,000 hp)
***Hiei* (DD 142):** 2 Ishikawajima boilers; 60 kg/cm² (850 psi); 480°C (900°F); 2 Ishikawajima turbines; 51.5 MW (70,000 hp)
Shafts: 2

Hiei (DDH 142) (H & L van Ginderen Collection)

FURTHER INFORMATION

PROGRAMME

These two Japanese ships were ordered under Japan's third five-year defence programme (from 1967-71) at a time when the popularity of the hybrid cruiser/helicopter-carrier was at its height, giving rise to designs such as the British Tiger, Soviet Moskva and Italian Vittorio Veneto. The Japanese ships have, however, proved more durable, and both ships have undergone a major modernisation and seem set to serve well into the next century.

DESIGN

The design can be effectively split into two at the large mack. Forward of the mack, the ship is pure destroyer, with a very large bridge, two 127 mm (5 in) guns, an ASROC Mk 112 launcher and two triple 324 mm torpedo tubes. Aft of the mack, however, the ship is all helicopter carrier, with a large hangar, which can accommodate three HSS-2B Sea Kings and a particularly spacious flight deck. Particular efforts have been made in the design to enable aircraft operations to continue despite bad weather, with fin stabilisers and a Canadian Beartrap haul-down for the helicopters.

In their original form the ships had only a limited air defence capability; in fact, it was essentially limited to the two 127 mm guns. This was rectified during the late 1980s mid-life modernisation (see below).

One aspect of the design not apparent in most pictures is that the mack is offset slightly to port in order to create space in the hangar for the third helicopter. There is also a large crane on the hangar roof.

MODERNISATION

Haruna (DD 141) was taken in hand from 31 March 1986 to 31 October 1987 for a mid-life modernisation by the builders Mitsubishi at Nagasaki. *Hiei* (DD 142) received a similar modernisation between 31 August 1987 and 30 March 1989 from its builders Ishikawajima Heavy Industries, Tokyo.

The prime aim of this work was to upgrade the air defence capabilities. This included installing a Sea Sparrow octuple launcher on the hangar roof and two 20 mm Mk 15 Phalanx CIWS, one either side of the mack. The ECM fit was also improved by fitting four SRBOC chaff launchers. Consideration was also given to fitting Harpoon launchers, but this did not take place.

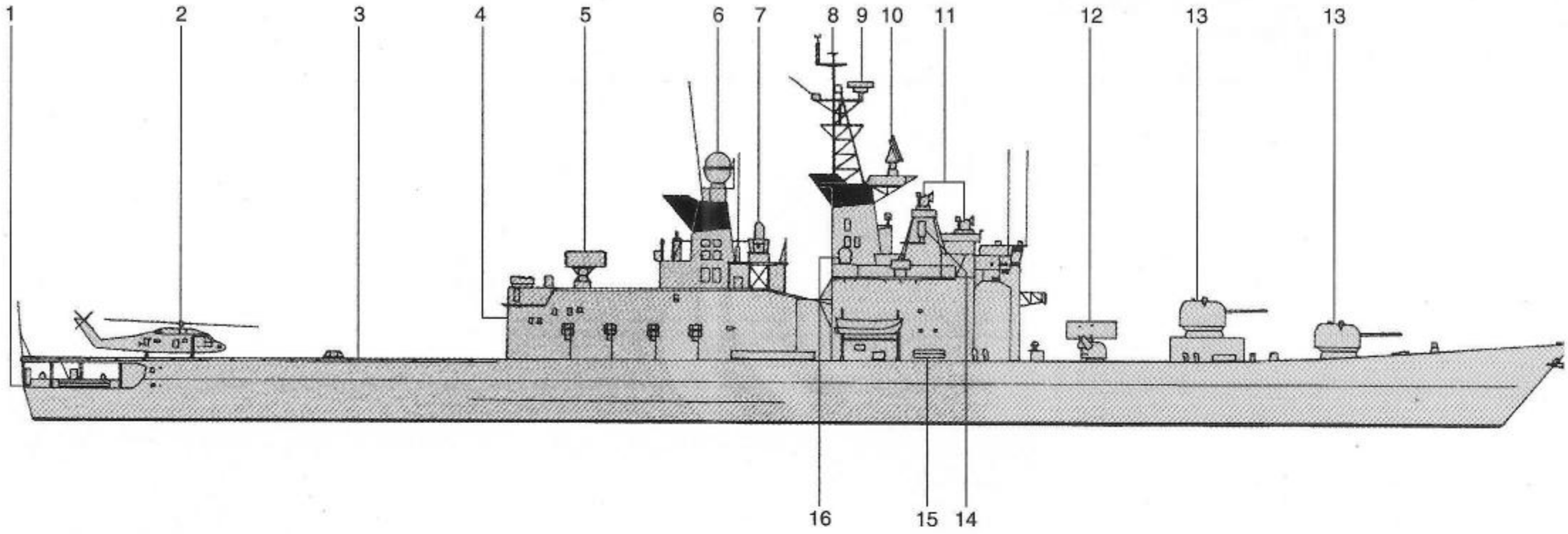
Hiei *(DDH 142) leading Escort Flotilla Four at sea (JMSDF)*

Hiei *(DDH 142)* (H & L van Ginderen Collection)

OPERATIONAL

Both ships are outfitted as flag ships and normally serve in that role, with *Haruna* as Flagship, 3rd Escort Flotilla (Maizuru) and *Hiei* as Flagship 4th Escort Flotilla (Kure).

SHIRANE



Shirane (Ian Sturton)

1 *EDO/NEC SQR-18A towed sonar array* **2** *Mitsubishi-Sikorsky SH-60J Seahawk* **3** *Flight deck* **4** *Hangar* **5** *Mk 29 eight-cell launcher for Sea Sparrow* **6** *Signaal WM-25 fire control (for Sea Sparrow)* **7** *Mk 15 Vulcan Phalanx 20 mm CIWS* **8** *ORN-6 TACAN* **9** *JRC OPS-28 radar (surface search)* **10** *NEC OPS-12 radar (air search)* **11** *Type 72-1A fire-control system (for 127 mm (5 in) guns)* **12** *Mk 112 ASROC eight-cell launcher* **13** *127 mm (5 in)/54 Mk 42 automatic gun mountings* **14** *Mitsubishi NOLQ-1 jammer* **15** *Type 68 324 mm triple torpedo launchers* **16** *Satcom*

GENERAL SPECIFICATIONS

Operator: Japan

Class: SHIRANE

Built: 2
Active: 2

Displacement:
standard: 5,200 t
full load: 6,800 t

Dimensions
Length: 159 m (521.5 ft)
Beam: 17.5 m (57.5 ft)
Draught: 5.3 m (17.5 ft)

Speed: 32 kts

Complement:
***Shirane* (DD 143):** 350
***Kurama* (DD 144):** 360

SHIPS

SHIRANE (DD 143)

Builder	Ishikawajima Harima, Tokyo, Japan
Laid down	25 Feb 1977
Launched	18 Sep 1978
Commissioned	17 Mar 1980

KURAMA (DD 144)

Builder	Ishikawajima Harima, Tokyo, Japan
Laid down	17 Feb 1978
Launched	20 Sep 1979
Commissioned	27 Mar 1981

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Raytheon Sea Sparrow point-defence missile system

Both ships are fitted with a Mk 29 octuple launcher for the Sea Sparrow system, using the RIM-7 Sea Sparrow missile; 24 missiles are carried. The system uses the Mitsubishi Type 2-12B fire-control system, which includes the large white radome atop the after deckhouse. The system is fully automatic from target acquisition to interception. The Sea Sparrow missile, although based upon the air-to-air Sparrow, has been enhanced for launching from ships, and has a 38.6 kg blast fragmentation warhead and a dual-purpose proximity-impact fuze.

Specifications

(RIM-7M)
Length: 3.66 m (12.0 ft)
Diameter: 20.3 cm (8.0 in)
Wing span: 1.02 m (3.35 ft)
Weight: 226.8 kg (500 lb)
Speed: Mach 2.5
Range: 8 n miles (14.5 km)
Warhead (WAU-17/B): 38.6 kg (85.1 lb)
Guidance: Semi-active radar

Manufacturers/Contractors

Raytheon Company, Equipment Division (prime systems contractor).
Raytheon Company, Missile Systems Division (prime missile contractor).
Hughes Missile Systems (second missile source).
Naval Weapons Center, Crane, USA (warhead).

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

Although ASROC is now no longer in service with the US Navy it remains in service with the JMSDF and in the 'Shirane' class there is a single Mk 112 launcher on the foredeck, with a magazine immediately beneath it. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 460 m (1,500 ft).

When a submarine target is detected it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (197 and 1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (1,968 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and as they separate the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications

ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor

Honeywell Training and Control Systems, West Covina, California.

TUBES

324 mm Type 68 (2 triple) torpedo launchers

Two triple 324 mm Type 68 torpedo tubes are sited amidships, one on either beam. This is a US Mk 32 installation, manufactured under licence in Japan.

Specifications

Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

Alliant Techsystems Mk 46 Mod 5 (Neartip) 324 mm torpedoes

Specifications

Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor

Alliant Techsystems, Mukilteo, Washington, USA.

GUNS

United Defense Mk 42 Single 127 mm (5 in)/54 gun mounting

The two Mk 42 mountings each house a single Mk 18 127 mm/54 gun and are located in 'A' and 'B' positions on the foredeck. The Mk 18 gun has a two-piece barrel with replaceable liner and a service life of some 2,000 rounds. A bayonet-type joint attaches the gun to the housing which includes a vertical sliding breech block and the entire gun assembly is supported on rollers in the slide. A separate rammer is mounted on the slide.

The Mk 42 mounting was introduced in 1953 and was produced in Japan under licence. The upper part of the mounting is fully power driven and is enclosed in an armoured shield. The Mk 42 mounting requires a crew of 12: four men within the shield and eight in the magazine and ammunition handling system.

Ammunition is loaded by a dual system with projectiles supplied automatically to the slide alternately from the right and left. The loading system consists of two manually loaded drums, one with 20 projectiles and the other with 20 charges, which rotate to bring the projectile and cartridge together. Complete rounds are lifted from the lower hoist to the upper hoist and from there to the cradles which move them to the tray from where they are rammed into the breech.

Magazine capacity is 550 rounds and ammunition includes the Mk 41 AAC/HC, Mk 42 common, and Mk 48 illumination rounds, all of which weigh 31.75 kg. All rounds have point detonating, proximity or mechanical time fuzes.

Specifications

Gun, 127 mm/54 Mk 18
Calibre: 127 mm
Length of barrel: 54 calibres
Muzzle velocity:
new barrel: 807 m/s (2,650 ft/s)
mid-life: 792 m/s (2,600 ft/s)
Max range: 12 n miles (22 km)
Max altitude: 14,400 m (47,000 ft)
Ammunition: 31.75 kg (70 lb)

Mounting, Mk 42
Traverse: 360° at 40°/s
Elevation: −15 to +85° at 25°/s
Rate of fire: 20-40 rds/min

Manufacturer/Contractor

United Defense Armaments Systems Division, Minneapolis, Minnesota, USA.

Hughes Mk 15 CIWS Phalanx

There are two Hughes Mk 15 Phalanx close in weapons systems (CIWS) situated on either side of the ship just forward of the after mack. The mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications

Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor

Hughes Missile Systems, Tucson, Arizona, USA (system).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES (ECM)

Mitsubishi NOLQ-1

NOLQ-1 is the standard JMSDF intercept/jammer and is reported to be very similar to the Raytheon AN/SLQ-32(V)3 (Sidekick).

Fujitsu OLR-9B

OLR-9B is a manually operated radar warning and intercept system, similar to the US Navy's AN/WLR-11.

Prairie Masker

The ships are fitted with the US Navy's Prairie Masker 'blade-rate suppression' system.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

OYQ-5

OYQ-5 is a Japanese tactical data processing system based on the US Navy's UKY-20 computer, which controls air defence missiles and guns through their respective fire-control systems. OYQ-5 interfaces with Link 11.

COMMUNICATIONS AND DATALINKS

The ships are fitted for:

Link 11, Link 14
Satcom

WEAPONS CONTROL

Loral Mk 114 ASW fire-control system

The Singer Mk 114 is the fire-control system for ASW operations. The main element is the Mk 53 Attack Console, an electromechanical analogue system which consists of two major units, the attack plotter and the ballistic computer. The latter conducts weapon presets for both ASROC and ASW torpedoes. The Mk 114 system also includes the Mk 33 underwater fire-control switchboard which accepts data from two Mk 19 gyrocompasses and other sensors, as well as from the Mk 134 sonar stabilisation computer. The consoles have an AN/UYK-44 reconfigurable processor with some 70,000 lines of CMS-2 language code.

The Mk 114 interfaces with the sonars: in this case, the EDO/NEC SQS-35(J) VDS, the bow-mounted NEC OQS-101; and the EDO/NEC SQR-18A towed array.

Manufacturer/Contractor

Loral Librascope.

Mitsubishi GFCS Model 1 (Type 72)

The Gun Fire Control System (GFCS) Model 1A (also known as the Type 71-1A) is the JMSDF's fire-control system for 127 mm (5 in) guns.

RADARS

NEC OPS-12

OPS-12 is a 3D air search radar, using a large, rectangular planar array. It operates in the D-band and has a range of some 65 n miles (119 km)

JRC OPS-28

OPS-28 is a surface search and short-range air search radar, operating in the G and H bands.

Koden OFS-2D

The OFS-2D is the navigation radar, operating in the I band.

Signaal WM-25

The WM-25 is the fire-control system for Sea Sparrow and is housed in the egg-shaped radome at the top of the after stack. The radar operates in the I and J bands and has a range of some 25 n miles (46 km).

SONARS

EDO/NEC SQS-35(J)

The EDO/NEC AN/SQS-35 is a variable depth sonar (VDS) designed to detect submarines at medium ranges. It uses an array with 24 staves, operates at 13 kHz and has a peak power of 30 kW. It is a single console system with the miniaturised vacuum-tube electronics of the earlier versions replaced by solid-state electronics in the SQS-35(J).

NEC OQS-101

OQS-101 is a Japanese-designed and -built bow-mounted sonar, operating at low frequencies.

EDO/NEC SQR-18A

The EDO AN/SQR-18A is a low-noise, passive, very low frequency, towed array sonar. It is 230 m long and is towed behind a cable up to 1.5 km long. The system features an interference canceller to reduce interference from the ship's noise and a tracker system to provide bearing resolution and target motion analysis (TMA).

AVIATION

AVIATION FACILITIES

Specifications

Flightdeck: 46 m × 17.5 m (150 × 57.5 ft)
Equipment: Indal Bear Trap helicopter hauldown gear

HELICOPTERS

These ships originally embarked three HSS-2B Sea King helicopters, but these aircraft have now been replaced by three SH-60J Seahawk.

Specifications

Main rotor:
diameter: 16.36 m (53.66 ft)
disc area: 210.15 m² (2,262 sq ft)
Tail rotor:
diameter: 3.35 m (11.00 ft)
disc area: 8.83 m² (95.03 sq ft)
Length overall:
fuselage: 15.26 m (50.0 ft)
rotors turning: 19.76 m (64.83 ft)
Height overall, tail rotor turning: 5.18 m (17.0 ft)
Weight empty: 6,191 kg (13,648 lb)
Mission gross weight: 9,182 kg (20,244 lb)
Performance
Dash speed at 1,525 m (5,000 ft), tropical day: 126 kts (234 km/h)
Vertical rate of climb at S/L, 32.2°C (90°F): 213 m (700 ft)/min
Power plant: 2 General Electric T700-GE-401 turboshafts rated at 1,260 kW (1,690 shp) 1,342 kW (1,800 shp)
Accommodation: Pilot and airborne tactical officer/back-up pilot in cockpit, sensor operator in specially equipped station in cabin
Radar: Japanese HPS-104 search radar
Flight: Japanese automatic flight management system and ring laser gyro AHRS
Instrumentation: Japanese controls and displays subsystem, datalink and tactical data processor
Mission: Japanese HQS-103 sonar; Texas Instruments AN/ASQ-81D2(V) MAD; Ednac AN/ARR-75 sonobuoy receiver
Self-defence: General Instruments AN/ALR-66 (VE) RWR; Japanese HLR-108 ESM
Armament: 2 Mk 46 torpedoes or depth bombs

Kurama *(DDH 144). Even the Sea King is dwarfed by the flight deck which is 46 m (150 ft) long and 17.5 m (57.5 ft) wide* (H & L van Ginderen Collection)

PROPULSION

Specifications

System: Steam turbines
Main machinery: 2 Ishikawajima boilers; 60 kg/cm² (850 psi); 480°C (900°F); 2 Ishikawajima turbines; 51.5 MW (70,000 hp (m))
Shafts: 2

Shirane *(DDH 143) showing the pronounced knuckle which runs virtually the entire length of the hull. These two ships have the same beam (17.5 m (57.5 ft)) as the earlier 'Haruna' class but are 5.8 m (19 ft) longer*

FURTHER INFORMATION

PROGRAMME

These two ships are improved versions of the 'Haruna' class, but with more effective air defence systems and improved electronics. One ship was authorised in each of the 1975 and 1976 programmes.

DESIGN

The 'Shirane' class hulls have the same beam as the 'Haruna' class, but are 5.8 m (19 ft) longer. Like the 'Haruna' class, they also have two 127 mm (5 in) guns and an ASROC launcher on the foredeck, and a very large flight deck aft, but can be distinguished by their two 'macks' stacks with their very odd-shaped cowls. Although not apparent in side views, the after stack is offset to port and the forward one to starboard. Both are fitted with Vosper Thornycroft fin stabilisers and there is a large crane on the starboard after corner of the hangar.

The ships were built to operate three HSS-2B Sea Kings, but both now operate three SH-60J Seahawk helicopters.

Like the Harunas, these ships also have a prominent knuckle running the full length of the hull.

MODERNISATION

DD 143 underwent a major refit in 1989-90 and both had been fitted with CIWS and towed array sonars by mid-1990.

OPERATIONAL

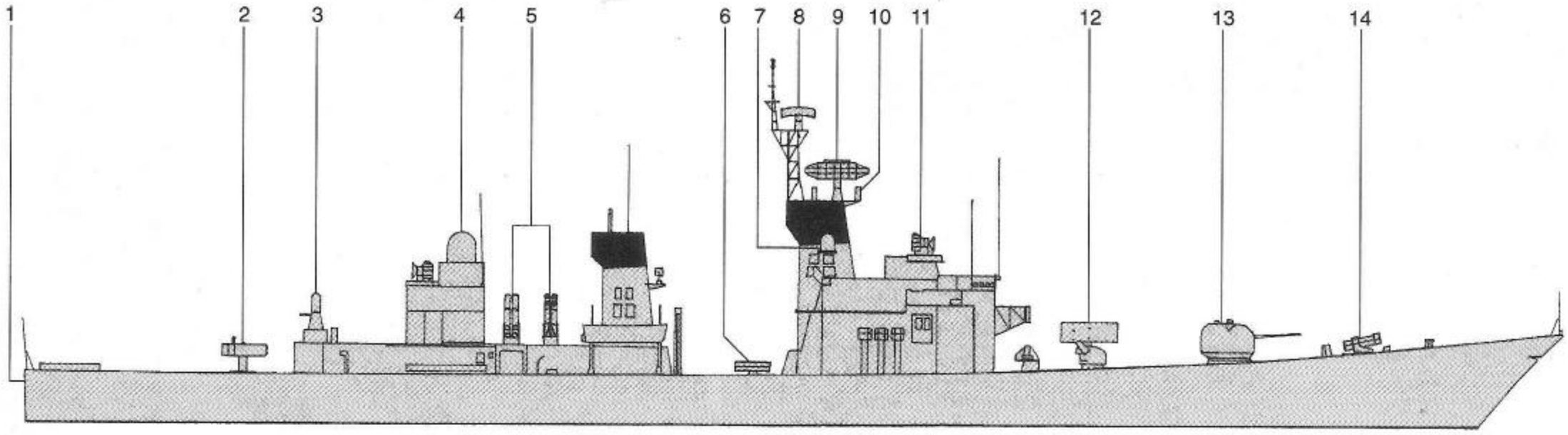
Both are fitted to serve as flagships for a rear-admiral and his staff and their normal employment is:

Shirane (DD 143) — Flagship, 1st Escort Flotilla (Yokosuka)

Kurama (DD 144) — Flagship, 2nd Escort Flotilla (Sasebo).

Shirane *(DDH 143). The superstructure shows a satellite dish in front of the bridge, while on the bridge roof are two platforms for the Type 72-1A fire-control directors for the 127 mm (5 in) guns. On the side of the higher tower is an NOLQ-1 jammer. On the mack is the rectangular array of the NEC OPS-12 3D air search radar, with the OPS-28 surface search radar on the small platform above it. Atop the after stack is the Signaal WM-25 'egg', one of the very few instances where the JMSDF has used a European radar system*

TAKATSUKI



Kikuzuki (Ian Sturton)

1 *EDO SQR-18 TACTASS* **2** *Mk 29 eight-cell launcher for Sea Sparrow* **3** *Mk 15 Vulcan Phalanx 20 mm CIWS* **4** *Type 2-12B fire control* **5** *Harpoon anti-ship missiles (eight)* **6** *Type 68 324 mm triple torpedo launchers (two)* **7** *Fujitsu OLT-3 jammer* **8** *JRC OPS-17 radar (surface search)* **9** *MELCO OPS-11B radar (air search)* **10** *NEC OLR-9 radar intercept* **11** *GFCS-1A fire control (127 mm (5 in) guns)* **12** *Mk 112 ASROC eight-cell launcher* **13** *127 mm (5 in)/54 Mk 42 automatic gun* **14** *Bofors Type 71 375 mm four-barrelled ASW mortar*

GENERAL SPECIFICATIONS

Operator: Japan

Class: TAKATSUKI

Built: 4
Active: 2

Displacement:
standard: 3,250 t
full load: 4,500 t

Dimensions
Length: 136 m (446.1 ft)
Beam: 13.4 m (44 ft)
Draught: 4.5 m (14.8 ft)

Speed: 31 kts
Range: 7,000 n miles at 20 kts

Complement:
DD 164, DD 165: 260
DD 166, DD 167: 270

SHIPS

TAKATSUKI (DD 164)	
Builder	Ishikawajima Harima, Tokyo, Japan
Laid down	8 Oct 1964
Launched	7 Jan 1966
Commissioned	15 Mar 1967
Modernised	Apr 1984-Oct 1985

KIKUZUKI (DD 165)	
Builder	Mitsubishi, Nagasaki, Japan
Laid down	15 Mar 1966
Launched	25 Mar 1967
Commissioned	27 Mar 1968
Modernised	May 1985-Dec 1986

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas UGM-84B Harpoon

Eight Harpoon anti-ship missile canisters are mounted immediately abaft the after stack; there are two groups of four launchers each, with one group pointing to either beam. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options. One of these is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low land-masses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

SURFACE-TO-AIR MISSILES (SAM)

Raytheon Sea Sparrow point-defence missile system

Both ships are fitted with a Mk 29 octuple launcher for the Sea Sparrow system, using the RIM-7 Sea Sparrow missile; 16 missiles are carried. The system uses the Mitsubishi Type 2-12B fire-control system, which includes the large white radome atop the after deck-house. The system is fully automatic from target acquisition to interception. The Sea Sparrow missile, although based upon the air-to-air Sparrow, has been enhanced for launching from ships, and has a 38.6 kg blast fragmentation warhead and a dual-purpose proximity-impact fuze.

Specifications

(RIM-7M)
Length: 3.66 m (12.0 ft)
Diameter: 20.3 cm (8.0 in)
Wing span: 1.02 m (3.35 ft)
Weight: 226.8 kg (500 lb)
Speed: Mach 2.5
Range: 8 n miles (14.5 km)
Warhead (WAU-17/B): 38.6 kg (85.1 lb)
Guidance: Semi-active radar

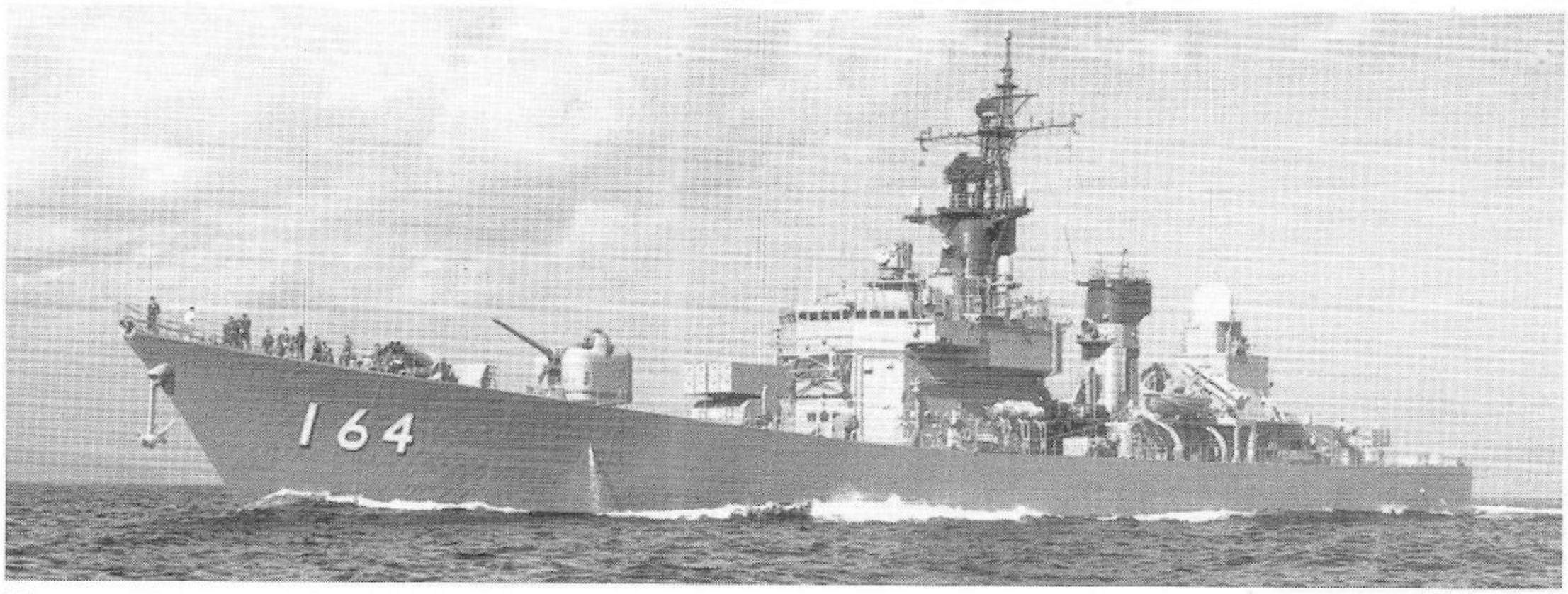
Manufacturers/Contractors

Raytheon Company, Equipment Division (prime system contractor).
Raytheon Company, Missile Systems Division (prime missile contractor).
Hughes Missile Systems (second missile source).
Naval Weapons Center, Crane, USA (warhead).

ANTI-SUBMARINE MISSILE

Honeywell RUR-5A ASROC

Although ASROC is now being removed from US Navy ships, it remains in service with the JMSDF and in the 'Takatsuki' class there is a single Mk 112 launcher on the foredeck, with a magazine immediately beneath it. ASROC consists of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 460 m (1,500 ft).



Takatsuki *(DD 164) is one of the two ships of this four-ship class remaining in service. Built in the 1960s both have been modernised while in service and armament now comprises one 127 mm (5 in) gun, one Mk 112 ASROC launcher, eight Harpoons (four can be seen abaft after mack) and a Sea Sparrow launcher on the quarterdeck.* Takatsuki *is fitted for a single Phalanx CIWS, but it has never been installed. Note also the Bofors Type 71 four-barrelled ASW mortar on the foredeck (immediately above the figure '4')* (Hachiro Nakai)

When the ship sensors detect a submarine target it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (197 and 1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (1,968 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and as they separate the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications

ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor

Honeywell Training and Control Systems, West Covina, California, USA.

TUBES

324 mm Type 68 (2 triple) tubes

Two triple 324 mm Type 68 torpedo tubes are sited amidships, one on either beam. This is a US Mk 32 installation, manufactured under licence in Japan.

Specifications

Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

Manufacturer/Contractor

GEC-Marconi Naval Systems Inc, UK.

TORPEDOES

Alliant Techsystems Mk 46 Mod 5 (Neartip) 324 mm torpedoes

Specifications

Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507.0 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: Liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

GUNS

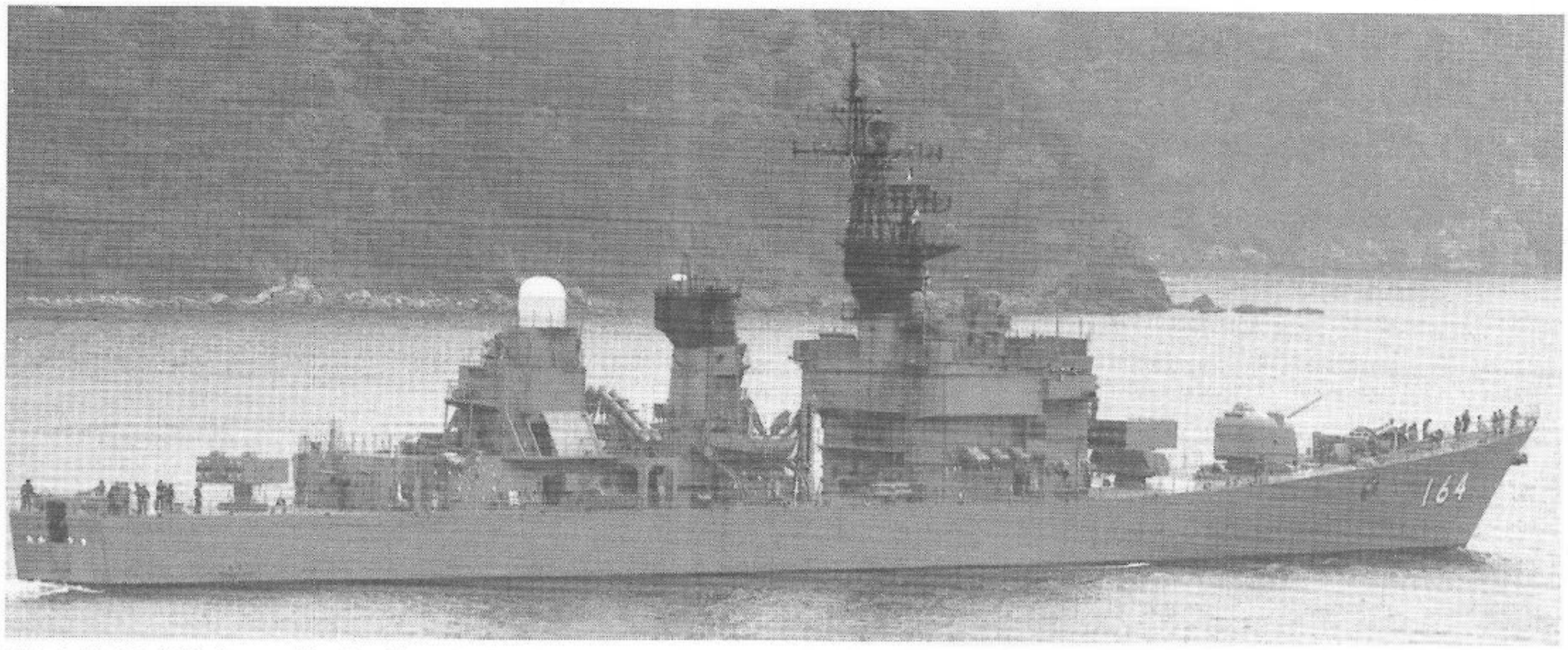
United Defense Mk 42 Single 127 mm (5 in)/54 gun mounting

The Mk 42 mounting houses a single Mk 18 127 mm/54 gun and is located in 'A' position on the foredeck. The Mk 18 gun has a two-piece barrel with replaceable liner and a service life of some 2,000 rounds. A bayonet-type joint attaches the gun to the housing which includes a vertical sliding breech block and the entire gun assembly is supported on rollers in the slide. A separate rammer is mounted on the slide.

The Mk 42 mounting was introduced in 1953 and was produced in Japan under licence. The upper part of the mounting is fully power driven and is enclosed in an armoured shield. The Mk 42 mounting requires a crew of 12: four men within the shield, and eight in the magazine and ammunition handling system.

Ammunition is loaded by a dual system with projectiles supplied automatically to the slide alternately from the right and left. The loading system consists of two manually loaded drums, one with 20 projectiles and the other with 20 charges, which rotate to bring the projectile and cartridge together. Complete rounds are lifted from the lower hoist to the upper hoist and from there to the cradles which move them to the tray from where they are rammed into the breech.

Magazine capacity is 550 rounds and ammunition includes the Mk 41 AAC/HC, Mk 42 common, and Mk 48 illumination rounds, all of which weigh 31.75 kg. All rounds have point detonating, proximity or mechanical time fuzes.



Takatsuki *(DD 164) after modification. Note the door for TACTASS in the transom, the Sea Sparrow launcher on the quarterdeck and the Harpoon launchers. The space and fittings for a Vulcan Phalanx CIWS abaft the Type 2-12B fire director can be seen, but the weapon was never fitted* (Hachiro Nakai)

Specifications
Gun, 127 mm/54 Mk 18
Calibre: 127 mm
Length of barrel: 54 calibres
Muzzle velocity:
new barrel: 807 m/s
mid-life: 792 m/s
Max range: 12 n miles (22 km)
Max altitude: 14,400 m (47,000 ft)
Ammunition: 31.75 kg

Mounting, Mk 42
Traverse: 360° at 40°/s
Elevation: −15 to +85° at 25°/s
Rate of fire: 20-40 rds/min

Manufacturer/Contractor
United Defense Armament Systems Division, Minneapolis, Minnesota, USA.

Hughes Mk 15 CIWS Phalanx
***(Kikuzuki* (DD 165) only.)** There is one Hughes Mk 15 Phalanx close in weapons system (CIWS) situated atop the after deckhouse, which replaced the former DASH hangar. The mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds. *Takatsuki* (DD 164) is fitted for but not with CIWS.

Specifications
Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor
Hughes Missile Systems, Tucson, Arizona, USA (systems).

ANTI-SUBMARINE MORTARS

Mitsubishi (Bofors) Type 71 375 mm ASW rocket system
There is a single, four-tube Type 71 ASW rocket launcher on the forecastle. This is the Bofors 375 mm rocket system, produced in Japan under licence by Mitsubishi Heavy Industries. The system consists of a rocket launcher, a handling system, the ship sonar and a fire-control system.

The four launch tubes are mounted on trunnions with an automatic contact device to connect the rockets with the fire-control system. The hydraulic laying machinery is in the front of the mounting and a flame deflector in the rear. Each system features an automatic electrohydraulic handling system. The rounds are stored vertically beneath the mounting and selected by an operator. A grab on a roof-mounted rail picks up the round by the nose and transfers it to the loading table. A hoist brings this through the deck hatch to where the launch tubes have been elevated to their loading position. The rounds are then inserted through the rear of the launch tube.

The magazine holds 48 rounds and reload time is three minutes, each tube being loaded separately. The rate of fire is one round a second and rockets may be fired singly or in salvos. There are two types of rocket, both with Hexotonal filling. The Type E (Erika) rocket has Stidar time and impact fuzes, while the Type N (Nelli) uses the Zambo proximity and impact fuzes.

Specifications
Launcher
Tubes: 4
Traverse: 260° at 18°/s
Elevation: −15 to +90° at 18°/s
Crew: 4

Rockets

	Type E	Type N
Weight	250 kg (551 lb)	230 kg (507 lb)
Muzzle velocity	130 m/s (427 ft/s)	205 m/s (673 ft/s)
Explosive weight	107 kg (236 lb)	80 kg (176 lb)
Range	0.35-0.87 n miles (0.65-1.63 km)	0.85-2.11 n miles (1.58-3.62 km)
Sinking speed	10.7 m/s (35.1 ft/s)	9.2 m/s (30.2 ft/s)

Manufacturer/Contractor
Mitsubishi Heavy Industries, Kobe, Japan.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

NEC NOLR-6C
***(Takatsuki* only.)** NOLR-6C is a radar intercept system, which was developed from the NOLR-5 in order to counter an anti-ship missile. It uses two rotating DF antennas to cover the main radar frequencies, with a circular dipole array mounted on the foretop to carry out direction-finding in the VHF and UHF bands. It uses electronic scanning. It is reported to be similar in many respects to the US Navy's AN/WLR-8.

NEC OLR-9
***(Kikuzuki* only.)** Only a few OLR-9 radar intercept systems appear to have been acquired by the JMSDF, one of which is installed in *Kikuzuki* instead of NOLR-6. It is believed that OLR-9 is similar to the US Navy's AN/WLR-11, but no further details are available.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher
There are two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications
Launcher
Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Rounds
Diameter: 130 mm (5.1 in)
Length, weight:
Mk 182: 1,209 mm; 22.7 kg
Super Chaffstar: 1,209 mm; 20.9 kg
Super Gemini: 451 mm; 5.5 kg
Super Hiram III: 1,220 mm; 13.6 kg
Super Hiram IV: 467 mm; 3.8 kg
Super Loroc: 734 mm; 13.2 kg

Manufacturers/Contractors
Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

Fujitsu OLT 3
Both ships are fitted with the OLT-3 jammer.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

OYQ-5 action data automation
OYQ-5 is a tactical data processing system based on the US Navy's UYK-20 computer, which controls air defence missiles and guns through their respective fire-control systems. OYQ-5 interfaces with Link 11.

COMMUNICATIONS AND DATALINKS

Link 11
Link 14
Satcom.

WEAPONS CONTROL

Fire-Control System Model 2-12B
FCS-2-12B is the weapons control system for Sea Sparrow. The associated radar operates in the I/J bands

GFCS Model 1A
GFCS (Gun Fire Control System) Model 1A is the control system for the 127 mm (5 in) gun.

RADARS

Mitsubishi OPS-11B
The OPS-11B is the primary air search radar.

JRC OPS-17
JRC OPS-17 is the surface search radar, operating in the G/H bands.

General Electric Mk 35
The GE Mk 35 is a fire-control radar, operating in the I/J band.

SONARS

OQS-3
OQS-3 is a licence-built version of the US Navy's AN/SQS-23 bow sonar. The latter is a late 1950s, bow-mounted, active, search and attack sonar, operating at medium frequency (5 kHz).

EDO AN/SQR 18-TACTASS
TACTASS has been installed in place of the previous VDS system.

PROPULSION

Specifications
System: Steam-turbines
Main machinery: 2 boilers; 60 kg/cm² (600 psi); 454°C (850°F); 2 Mitsubishi turbines; 51.5 MW (70,000 hp (m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

This class originally comprised four ASW destroyers and was built at the same time as the 'Yamagumo' and 'Minegumo' class. At the time they were commissioned the Takatsukis were the largest warships to have been built in Japan since the Second World War. Four were built, of which two were substantially rebuilt in the mid-1980s.

DESIGN

These ships were designed for the ASW mission and were built around the US DASH helicopter system, with a large hangar and flight deck aft to accommodate three of the drones. They were also armed with an ASROC launcher on the foredeck, a quadruple Bofors 375 mm ASW rocket launcher in the bow, and two sets of 324 mm torpedo tubes amidships. In contrast, air and surface armaments were weak, comprising two 127 mm (5 in) guns, one of which was forward, ahead of the ASROC launcher and the second aft, on the roof of the deckhouse immediately forward of the DASH hangar.

As built, there were minor differences between the ships. The second of class, *Kikuzuki,* is the only one to have fin stabilisers, while the third and fourth, *Mochizuki* and *Nagatsuki* (now both paid off), had a distinct knuckle in the bows.

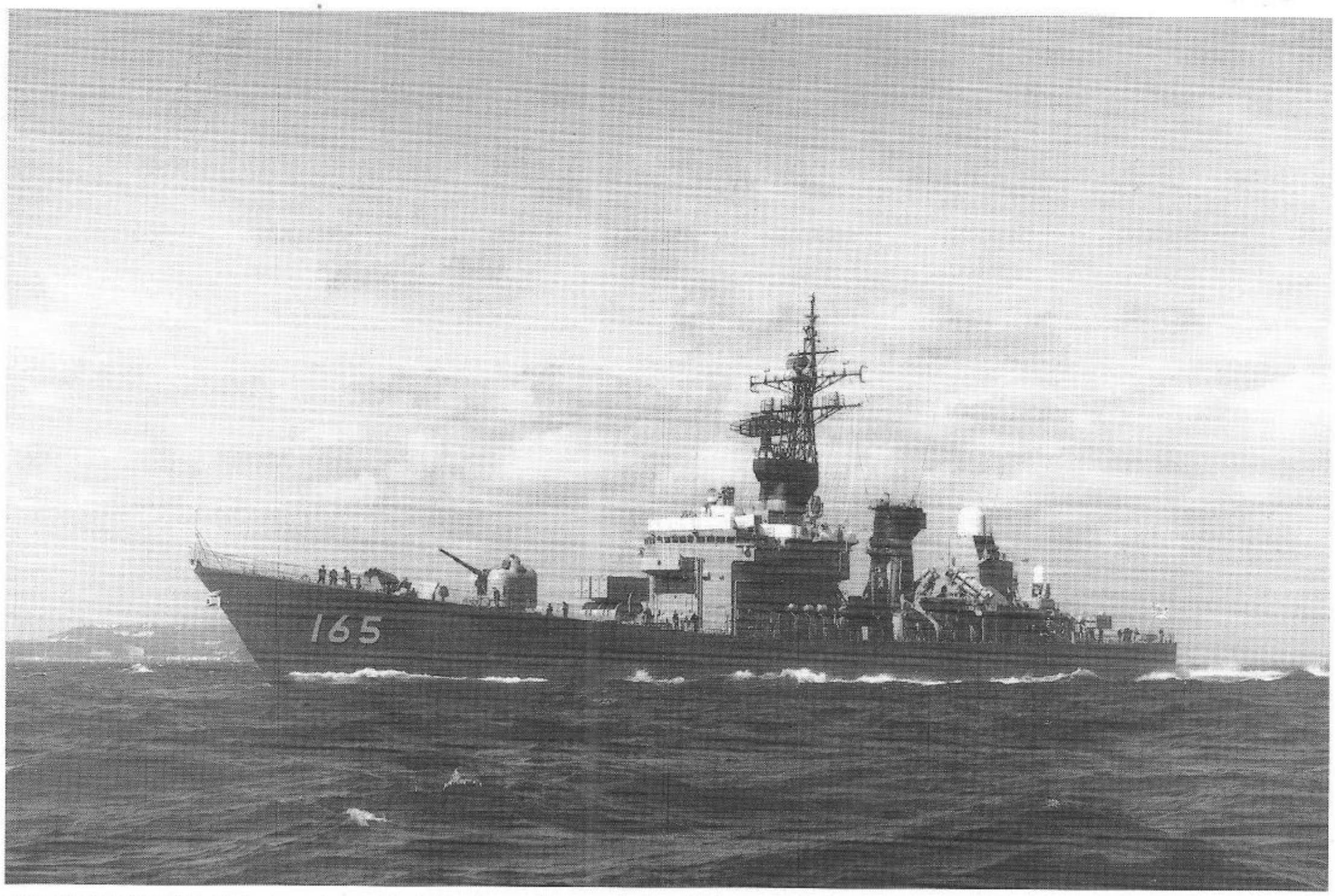
MODERNISATION

The first major change to the class was the fitting of VDS in all four ships between 1970 and 1972. It was then planned to give all four a major mid-life update, but, in the event, only the first two ships, *Takatsuki* and *Kikuzuki,* were involved: *Takatsuki* from 1 April 1984 to 31 October 1985 and *Kikuzuki* from May 1985 to December 1986. This involved removing the after 127 mm gun, the DASH hangar and VDS, and the installation of Harpoon, Sea Sparrow and its associated FCS-2 and TASS. In addition, both ships were fitted for Phalanx CIWS, with *Kikuzuki* receiving the actual system during the refit, although *Takatsuki's* has never been installed. NOLR-9 was installed in *Kikuzuki* (DD 165) for trials in 1991/92.

Due to the cancellation of the modernisation programme when only half complete, the curious situation has arisen where the newest ships of the class have left active service first. *Mochizuki* was converted to a training support ship on 1 April 1995 and now bears the number ASU 7019, while *Nagatsuki* was paid off in mid-1996.

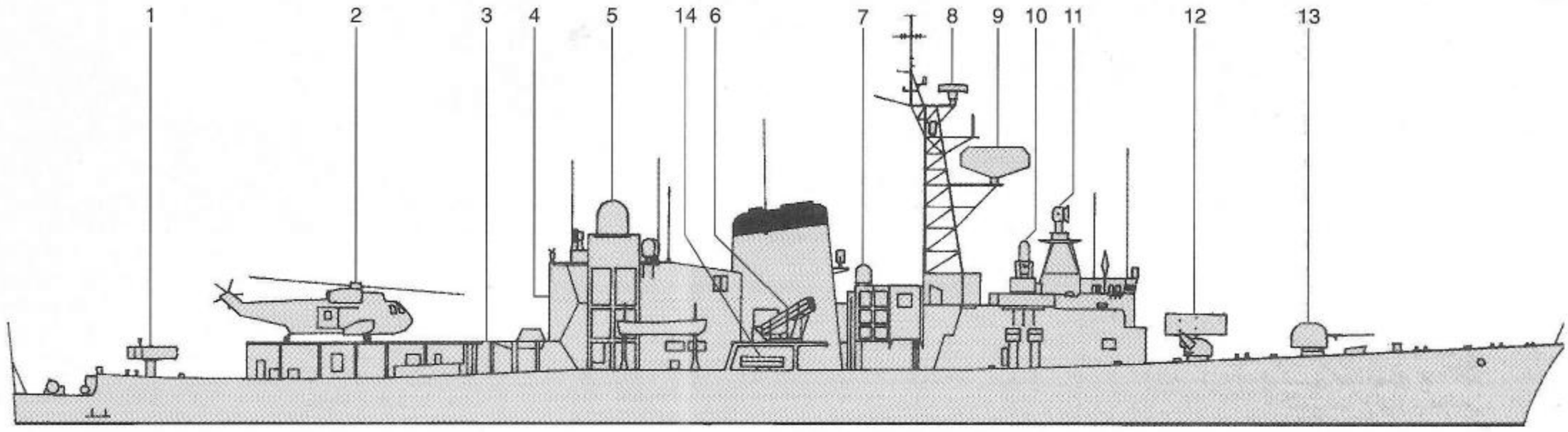
DEPLOYMENT

The two remaining ships of this class have been removed from the escort flotillas and now serve with district flotillas.



Kikuzuki *(DD 165) is the second remaining ship of this class and was modernised in the same fashion as* Takatsuki. Kikuzuki, *however, had the Phalanx CIWS fitted and the thimble radome can be seen aft of the large white radome of the Type 2-12B fire director* (Hachiro Nakai)

HATSUYUKI



1 *Raytheon Type 3 launcher for Sea Sparrow SAM* **2** *Mitsubishi HSS2-B Sea King helicopter* **3** *Flight deck* **4** *Hangar* **5** *Type 2-12A fire control (for SAM)* **6** *McDonnell Douglas Harpoon anti-ship missiles (eight)* **7** *Satcom* **8** *JRC OPS-18 surface search radar* **9** *MELCO OPS-18 air search radar* **10** *Hughes Mk15 20 mm CIWS (two)* **11** *Type 2-21A fire control (guns)* **12** *Mk 112 eight-cell launcher for ASROC* **13** *OTOBREDA 76 mm (3 in)/62 Compact automatic gun*

GENERAL SPECIFICATIONS

Operator: Japan

Class: HATSUYUKI

Built: 12
Active: 12

Displacement:
standard: DD 122 – DD 128 – 2,950 t; DD 129 – DD 133 – 3,050 t
full load: DD 122 – DD 128 – 3,700 t; DD 129 – DD 133 – 3,800 t

Dimensions
Length: 130 m (426.4 ft)

Beam: 13.6 m (44.6 ft)
Draught: DD 122 – DD 128 – 4.2 m (13.8 ft); DD 129 – DD 133 – 4.4 m (14.4 ft)

Speed: 30 kts

Complement: DD 122 – DD 123 – 195; DD 124 – DD 133 – 200

SHIPS

HATSUYUKI (DD 122)
Builder Sumitomo, Uraga, Japan
Laid down 14 Mar 1979
Launched 7 Nov 1980
Commissioned 23 Mar 1982

SHIRAYUKI (DD 123)
Builder Hitachi, Maizuru, Japan
Laid down 3 Dec 1979
Launched 4 Aug 1981
Commissioned 8 Feb 1983

MINEYUKI (DD 124)
Builder Mitsubishi, Nagasaki, Japan
Laid down 7 May 1981
Launched 19 Oct 1982
Commissioned 26 Jan 1984

SAWAYUKI (DD 125)
Builder Ishikawajima Harima, Tokyo, Japan
Laid down 22 Apr 1981
Launched 21 June 1982
Commissioned 15 Feb 1984

HAMAYUKI (DD 126)
Builder Mitsui, Tamano, Japan
Laid down 4 Feb 1981
Launched 27 May 1982
Commissioned 18 Nov 1983

ISOYUKI (DD 127)
Builder Ishikawajima Harima, Tokyo, Japan
Laid down 20 Apr 1982
Launched 19 Sep 1983
Commissioned 23 Jan 1985

HARUYUKI (DD 128)
Builder Sumitomo, Uraga, Japan
Laid down 11 Mar 1982
Launched 6 Sep 1983
Commissioned 14 Mar 1985

YAMAYUKI (DD 129)
Builder Hitachi, Maizuru, Japan
Laid down 25 Feb 1983
Launched 10 Jul 1984
Commissioned 3 Dec 1985

MATSUYUKI (DD 130)
Builder Ishikawajima Harima, Tokyo, Japan
Laid down 7 Apr 1983
Launched 25 Oct 1984
Commissioned 19 Mar 1986

SETOYUKI (DD 131)
Builder Mitsui, Tamano, Japan
Laid down 26 Jan 1984
Launched 3 Jul 1985
Commissioned 11 Dec 1986

ASAYUKI (DD 132)
Builder Sumitomo, Uraga, Japan
Laid down 22 Dec 1983
Launched 16 Oct 1985
Commissioned 20 Feb 1987

SHIMAYUKI (DD 133)
Builder Mitsubishi, Nagasaki, Japan
Laid down 8 May 1984
Launched 29 Jan 1986
Commissioned 17 Feb 1987

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas UGM-84B Harpoon

There are eight Harpoon anti-ship missile launch tubes in two groups of four. In virtually all other Japanese destroyers the Harpoon launchers are sited on one side of the ship pointing directly across to fire over the opposite beam; this makes for a tidy installation and also ensures that the greater part of the rocket efflux is ejected over the side. In the 'Hatsuyuki' class, however, the density of the superstructure makes such an arrangement impossible and launchers are on small platform decks, pointing forwards at an angle of about 20° to the centreline. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options. One of these is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

Raytheon Sea Sparrow point-defence missile system

These ships are fitted with a Type 3 (A-1) launcher using the RIM-7 Sea Sparrow missile. 12 missiles are carried. The system uses the Mitsubishi Type 2-12B fire-control system, which includes the large white radome atop the after deckhouse. The system is fully automatic from target acquisition to interception. The Sea Sparrow missile, although based upon the air-to-air Sparrow, has been enhanced for launching from ships, and has a 38.6 kg (85.1 lb) blast fragmentation warhead and a dual-purpose proximity-impact fuze.

Specifications
(RIM-7M)
Length: 3.66 m (12.0 ft)
Diameter: 20.3 cm (8.0 in)
Wing span: 1.02 m (3.35 ft)
Weight: 226.8 kg (500 lb)
Speed: Mach 2.5
Range: 8 n miles (14.5 km)
Warhead (WAU-17/B): 38.6 kg (85.1 lb)
Guidance: Semi-active radar

Manufacturers/Contractors
Raytheon Company, Equipment Division (prime system contractor).
Raytheon Company, Missile Systems Division (prime system contractor).
Hughes Missile Systems (second missile source).
Naval Weapons Center, Crane, USA (warhead).

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

There is a single Mk 112 launcher on the foredeck, with a magazine immediately behind it. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 460 m (1,500 ft).

When a submarine target is detected it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (197 and 1.000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (1,968 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and as they separate the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications
ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor
Honeywell Training and Control Systems, West Covina, California, USA.

TUBES

324 mm Type 68 (triple) torpedo launchers

Two Type 68 324 mm torpedo launchers, each consisting of three HOS 301 tubes, are sited amidships, one set on either beam. This is a US Mk 32 installation, manufactured under licence in Japan.

Yamayuki *(DD 129) at a British port. On the bridge roof are two Vulcan Phalanx CIWS with (between them) the Type 2-21 fire director for the 76 mm gun. The grey radome to the left of the starboard CIWS is the OLT-3 jammer and behind that can be seen four Harpoon SSM launchers. The flat plate array at the masthead is URN-25 TACAN. The white radome abaft the stack is Type 2-12A fire control for the Sea Sparrow SAM system* (Jane's/H M Steele)

Specifications
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

Alliant Techsystems Mk 46 Mod 5 torpedo

Specifications
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor
Alliant Techsystems, Mukilteo, Washington, USA.

GUNS

OTOBREDA 76 mm (3 in)/62 Compact

There is one OTOBREDA 76 mm (3 in) gun sited in 'A' position on the foredeck.

Specifications
Calibre: 76.2 mm (3.0 in)
Length of barrel: 4.72 m (15.49 ft)
Elevation: −15 to +85°at 40°/s
Traverse: 360° at 70°/s
Muzzle velocity: 900 m/s (2,953 ft/s)
Max rate of fire: 85 rds/min
Range: 8.6 n miles (16 km)

Manufacturer/Contractor
OTOBREDA, La Spezia, Italy.

Hughes Mk 15 CIWS Phalanx

There are two Hughes Mk 15 Phalanx close in weapons systems (CIWS) located either side of the after end of the bridge. The mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at a range of 1 n mile

(1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications

Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor

Hughes Missile Systems, Tucson, Arizona, USA (system).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

NEC NOLR-6C

(All except *Satayuki* (DD 131).) NOLR-6C is a radar intercept system, which was developed from the NOLR-5 in order to counter an anti-ship missile. It uses two rotating DF antennas to cover the main radar frequencies, with a circular dipole array mounted on the foretop to carry out direction-finding in the VHF and UHF bands. It uses electronic scanning. It is reported to be similar in many respects to the US Navy's AN/WLR-8.

NOLR-8

***(Setoyuki* (DD 131) only.)** *Setoyuki* (DD 131) does not have NOLR-6 and is fitted with the more up-to-date NOLR-8 , which is intended to replace both NOLR-6 and OLR-9. It is presumed that the *Setoyuki* installation was for seagoing trials.

OLT-3

All ships are fitted with the OLT-3 jammer.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher

There are two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications

Launcher
Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Rounds
Diameter: 130 mm (5.1 in)
Length, weight:
Mk 182: 1,209 mm; 22.7 kg
Super Chaffstar: 1,209 mm; 20.9 kg
Super Gemini: 451 mm; 5.5 kg
Super Hiram III: 1,220 mm; 13.6 kg
Super Hiram IV: 467 mm; 3.8 kg
Super Loroc: 734 mm; 13.2 kg

Manufacturers/Contractors

Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

OYQ-5 action data automation

The OYQ-5 is a tactical data processing system based on the US Navy's UYK-20 computer, which controls air defence missiles and guns through their respective fire-control systems. OYQ-5 interfaces with Link 14.

COMMUNICATIONS AND DATALINKS

Link 11
Link 14 (receive only)
Tacan: URN 25.

WEAPONS CONTROL

Mitsubishi GFCS Model 2-12B

This is the weapons control system for Sea Sparrow. The associated radar operates in the I/J bands.

Hatsuyuki *(DD 122). The very large stack dominates the ship, dwarfing even the bridge structure; it is fitted with IR suppressors and a water-spray cooling system. Note the Satcom radome below the Type 2-12 radome abaft the stack* (Hachiro Nakai)

Mitsubishi GFCS Model 2-21

There is one GFCS Model 2-21 (also known as the Type 79) system to control the fire of the gun. The radar operates in the I/J bands.

Manufacturer/Contractor

Mitsubishi Electric Corporation (MELCO), Tokyo, Japan.

RADARS

Mitsubishi OPS 14B

OPS-14B is a B/C-band air search radar. Peak power is 400 kW and beam width is 5°.

Manufacturer/Contractor

Mitsubishi Electric Corporation (MELCO), Tokyo, Japan.

OPS-18

OPS-18 is a G/H band surface search radar. It is being replaced by OPS-28.

SONARS

NEC OQS-4A (II)

OQS-4A (II) is a Japanese-designed, improved version of the OQS-3, which was a licence-produced version of the US Navy's SQS-23. OQS-4A is a bow-mounted, active search and attack sonar, operating at medium frequencies.

Manufacturer/Contractor

NEC, Tokyo, Japan.

OQR-1 (AN/SQR 18) TACTASS

TACTASS passive, low-frequency towed array is being installed in place of the previous VDS system. Most ships are now fitted.

AVIATION

AVIATION FACILITIES

Specifications

Flight deck: 26 × 13.7 m (95 × 44.6 ft)
Equipment: Indal Beartrap hauldown equipment

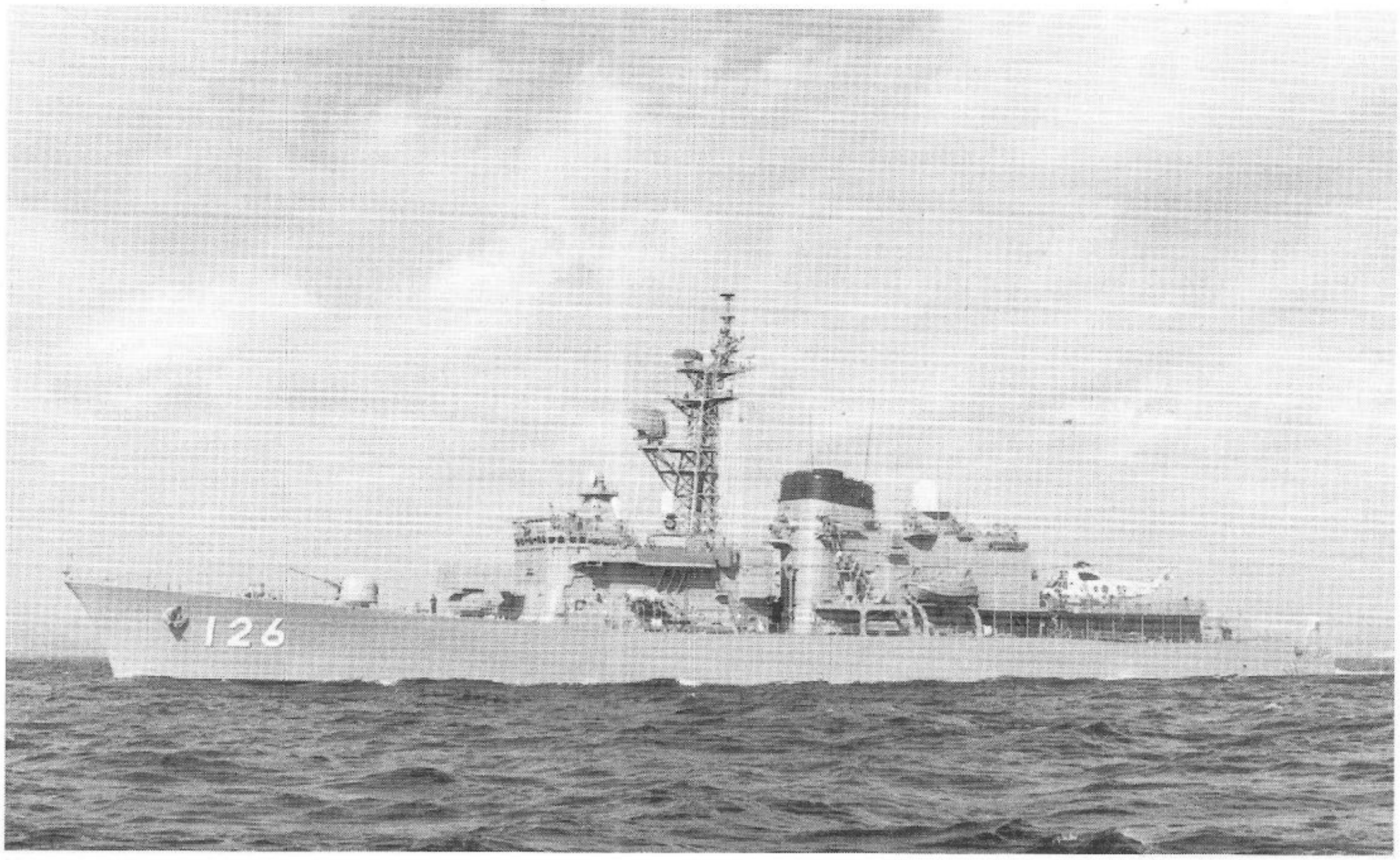
HELICOPTERS

Mitsubishi-Sikorsky SH-60J Seahawk

The class originally operated one Mitsubishi/Sikorsky HSS-2B Sea King but this has now been replaced by the SH-60J in seven of the class with the remainder rapidly following suit.

Specifications

Main rotor:
diameter: 16.36 m (53.66 ft)
disc area: 210.15 m² (2,262 sq ft)
Tail rotor:
diameter: 3.35 m (11.00 ft)
disc area: 8.83 m² (95.03 sq ft)
Length overall:
fuselage: 15.26 m (50.0 ft)
rotors turning: 19.76 m (64.83 ft)
Height overall, tail rotor turning: 5.18 m (17.0 ft)
Weight empty: 6,191 kg (13,648 lb)
Mission gross weight: 9,182 kg (20,244 lb)
Dash speed at 1,525 m (5,000 ft), tropical day: 126 kts (234 km/h)
Vertical rate of climb at S/L, 32.2°C (90°F): 213 m (700 ft)/min
Power plant: 2 General Electric T700-GE-401 turboshafts rated at 1,260 kW (1,690 shp) 1,342 kW (1,800 shp)
Accommodation: 3 (pilot and airborne tactical officer/back-up pilot in cockpit, sensor operator in specially equipped station in cabin)
Radar: Japanese HPS-104 search radar
Flight: Japanese automatic flight management system and ring laser gyro AHRS
Instrumentation: Japanese controls and displays subsystem, datalink and tactical data processor
Mission: Japanese HQS-103 sonar; Texas Instruments AN/ASQ-81D2(V) MAD; Ednac AN/ARR-75 sonobuoy receiver
Self-defence: General Instruments AN/ALR-66 (VE) RWR; Japanese HLR-108 ESM
Armament: 2 Mk 46 torpedoes or depth bombs



Hamayuki *(DD 126). At the time of this picture the ship was still operating an HSS-2B Sea King helicopter but virtually all the class have now converted to SH-60J Seahawk* (Hachiro Nakai)

PROPULSION

Specifications

System: Combined gas or gas (COGOG)
Main machinery: 2 Kawasaki-Rolls-Royce Olympus TM3B gas-turbines; 36.8 MW (49,400 hp) sustained; 2 Rolls-Royce Type RM1C gas-turbines; 7.4 MW (9,900 hp) sustained
Shafts: 2
Propellers: cp

FURTHER INFORMATION

PROGRAMME

These are general purpose destroyers, with a balanced capability for anti-air, surface and anti-submarine operations. They represent a complete break from previous designs, such as the 'Takatsuki' and 'Yamagumo' classes. The twelve ships represent the largest single class of major surface warships to have been built for the JMSDF and were completed between 1983 and 1987.

DESIGN

The dominant feature of the design is the huge stack which incorporates the uptakes for all four gas-turbines and is also fitted with passive IR suppressors as well as a water-spray cooling system. Apart from the OTO-BREDA 76 mm gun, all the weaponry is of US origin, but the electronic equipment is either of Japanese design or, if of foreign origin, is manufactured under licence in Japan.

As built, these ships operated a single HSS-2B Sea King, a large aircraft for this size of ship. Unlike European ships, however, which tend to have the flight-deck at the stern, the 'Hatsuyuki' class has the flight deck at the 01 deck level and an Indal Beartrap haul-down system is fitted. The ships are also fitted with fin stabilisers.

Aluminium alloy was used in the superstructure of DD 122 to DD 128, but from DD 129 onwards this was replaced by steel, which accounts for most of the 100 t increase in displacement in these later ships. Since DD 129 was laid down in February 1983 it seems reasonable to assume that this change resulted from a Japanese study of the lessons of the Falklands (Malvinas) war.

MODERNISATION

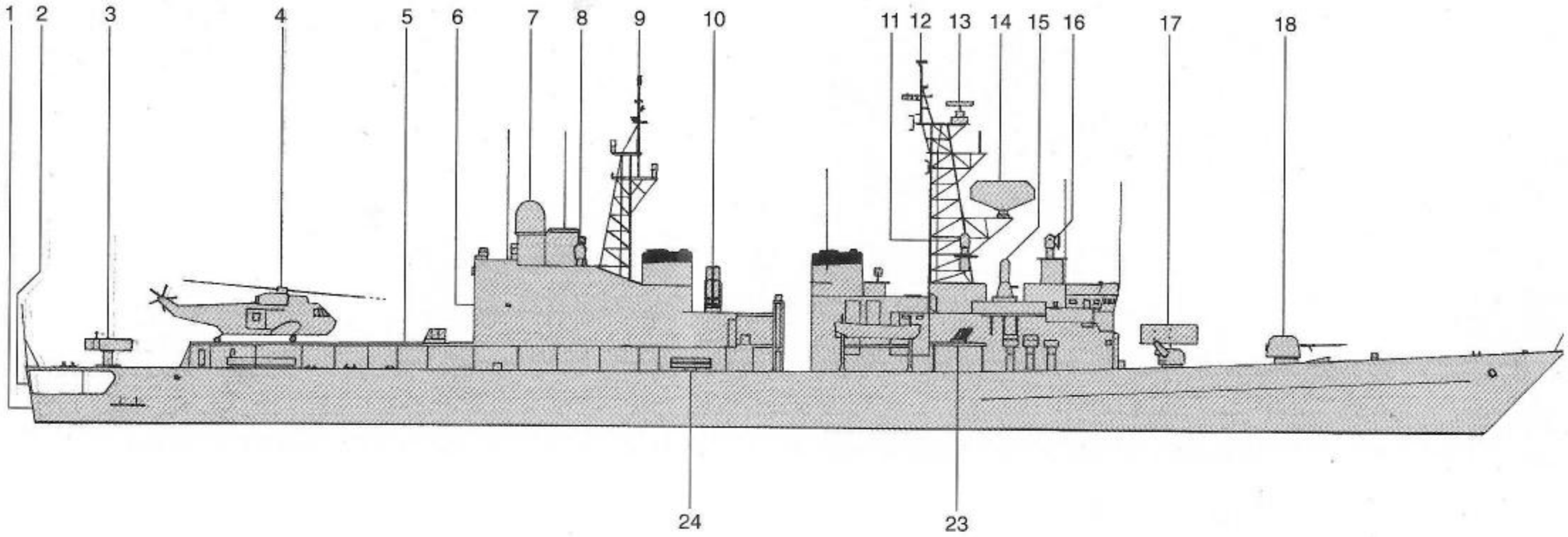
Much new equipment has been installed in the class. *Hamayuki* (DD 126) was fitted with Phalanx CIWS in 1987 and the rest of the class was completed by 1996. *Matsuyuki* (DD 130) was fitted with OQR-1 towed array sonar in 1990, followed by *Hatsuyuki* (DD 122) in 1994 and the others are following. The class is also being converted to take SH-60J Seahawk helicopters and seven had the new aircraft by 1996. Improved ECM equipment is also being fitted.

OPERATIONAL

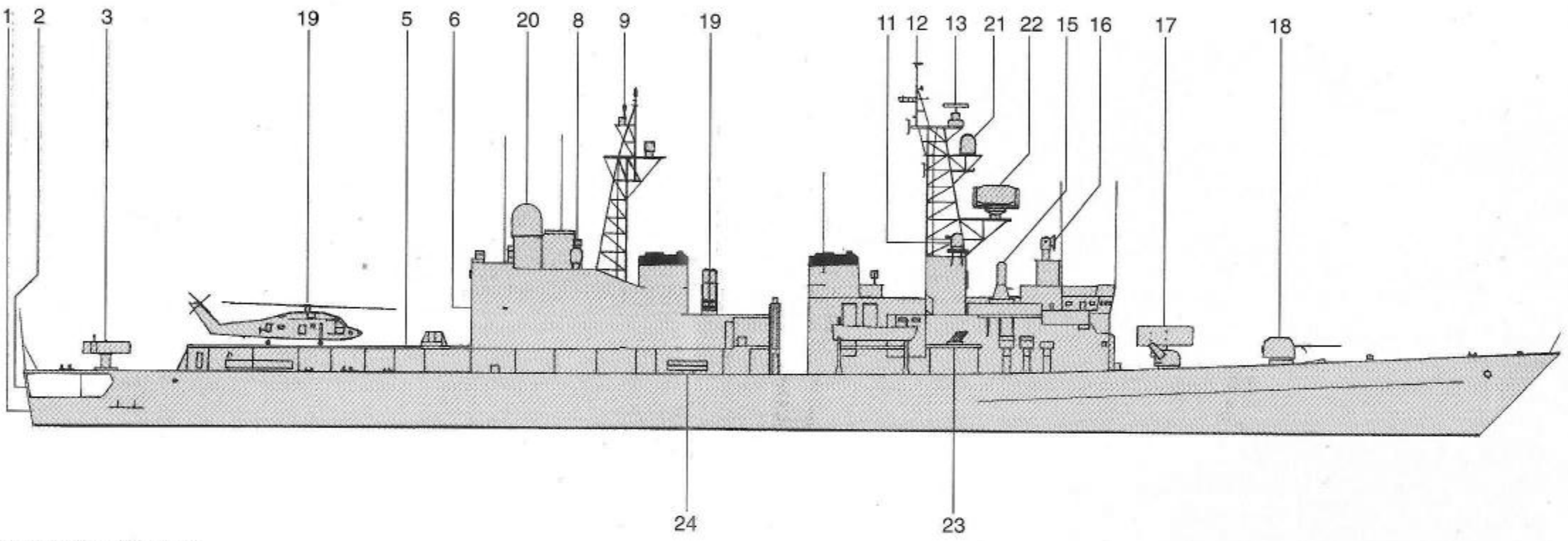
Most of the class is split between two escort flotillas:
2nd Escort Flotilla (Sasebo): *Isoyuki* (DD 127), *Haruyuki* (DD 128), *Yamayuki* (DD 129), *Matsuyuki* (DD 130)
3rd Escort Flotilla (Maizuru): *Mineyuki* (DD 124), *Hamayuki* (DD 126), *Setoyuki* (DD.131), *Asayuki* (DD 132), *Shimayuki* (DD 133).

Sawayuki (H & L van Ginderen Collection)

ASAGIRI



Asagiri (Ian Sturton)



Umigiri (Ian Sturton)

1 *OQR-1 towed array* **2** *SLQ-51 Nixie or Type 4 towed torpedo decoy* **3** *Mk 29 eight-cell launcher for Sea Sparrow* **4** *Mitsubishi HSS-2B Sea King* **5** *Flight deck* **6** *Hangar* **7** *Type 2-12E fire control for Sea Sparrow* **8** *Satcom* **9** *ESM/ECM antennas* **10** *Harpoon SSM (two quad launchers)* **11** *NOLR-6C ESM* **12** *ORN-6 TACAN* **13** *JRC OPS-28C radar (surface search)* **14** *MELCO OPS-14C radar (air search) (DD 151-154 only)* **15** *Mk 15 Vulcan Phalanx 20 mm CIWS* **16** *Type 2-22 fire control (gun)* **17** *Mk 112 eight-cell ASROC launcher* **18** *OTOBREDA 76 mm (3 in)/62 compact gun mounting* **19** *Mitsubishi SH-60J Sea Hawk LAMPS-III helicopter* **20** *Type 2-12G fire control (for Sea Sparrow)* **21** *SQQ-28 LAMPS-III datalink* **22** *MELCO OPS-24 radar (air search) (DD 155-158 only)* **23** *Mk 36 SRBOC chaff launchers* **24** *Type 62 324 mm torpedo launchers (two triple)*

GENERAL SPECIFICATIONS

Operator: Japan

Class: ASAGIRI

Built: 8
Active: 8

Displacement:
standard: DD 151 – DD 154 3,500 t; DD 155-158 – 3,550 t
full load: 4,200 t

Dimensions
Length: 137 m (449.4 ft)

Beam: 14.6 m (48 ft)
Draught: 4.5 m (14.6 ft)

Speed: 30+ kts

Complement: 220

SHIPS

ASAGIRI (DD 151)
Builder Ishikawajima Harima, Tokyo, Japan
Laid down 13 Feb 1985
Launched 19 Sep 1986
Commissioned 17 Mar 1988

YAMAGIRI (DD 152)
Builder Mitsui, Tamano, Japan
Laid down 5 Feb 1986
Launched 8 Oct 1987
Commissioned 25 Jan 1989

YUUGIRI (DD 153)
Builder Sumitomo, Uraga, Japan
Laid down 25 Feb 1986
Launched 21 Sep 1987
Commissioned 28 Feb 1989

AMAGIRI (DD 154)
Builder Ishikawajima Harima, Tokyo, Japan
Laid down 3 Mar 1986
Launched 9 Sep 1987
Commissioned 17 Mar 1989

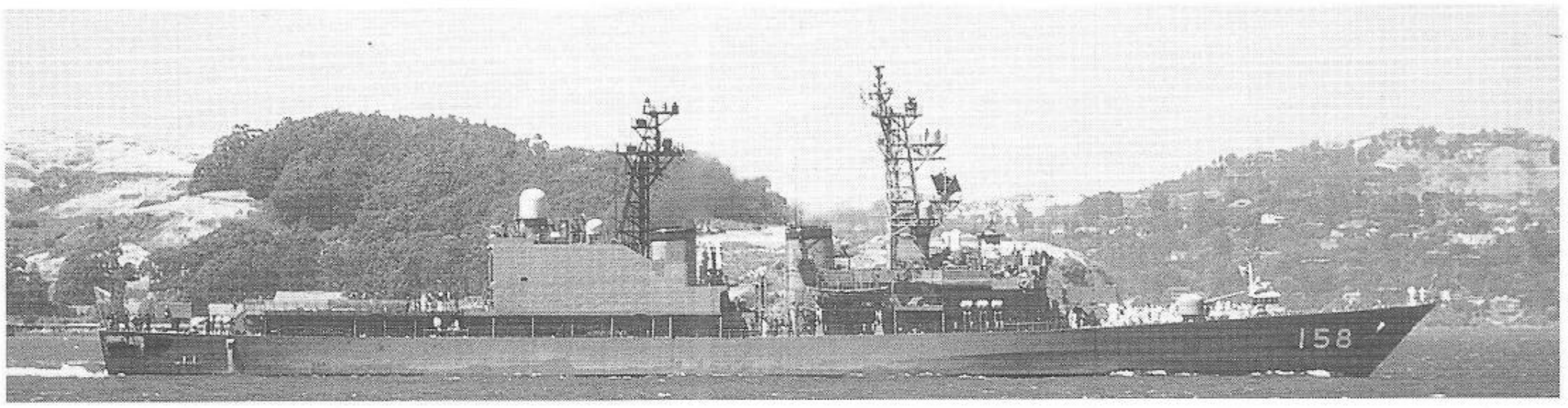
HAMAGIRI (DD 155)
Builder Hitachi, Maizuru, Japan
Laid down 20 Jan 1987
Launched 4 Jun 1988
Commissioned 31 Jan 1990

SETOGIRI (DD 156)
Builder Sumitomo, Uraga, Japan
Laid down 9 Mar 1987
Launched 12 Sep 1988
Commissioned 14 Feb 1990

SAWAGIRI (DD 157)
Builder Mitsubishi, Nagasaki, Japan
Laid down 14 Jan 1987
Launched 25 Nov 1988
Commissioned 6 Mar 1990

UMIGIRI (DD 158)
Builder Ishikawajima Harima, Tokyo, Japan
Laid down 31 Oct 1988
Launched 9 Nov 1989
Commissioned 12 Mar 1991

Setogiri *(DD 156). Note SH-60J, license-built Seahawk, on the flight deck* (H & L van Ginderen Collection)



Umigiri *(DD 158)* (H & L van Ginderen Collection)

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Raytheon Sea Sparrow point-defence missile system

There is a Mk 29 octuple launcher for the Sea Sparrow system, using the RIM-7 Sea Sparrow missile on the quarterdeck; 20 missiles are carried. The system uses the Mitsubishi Type 2-12B fire-control system, which includes the large white radome atop the after deckhouse. The system is fully automatic from target acquisition to interception. The Sea Sparrow missile, although based upon the air-to-air Sparrow, has been enhanced for launching from ships, and has a 38.6 kg blast fragmentation warhead and a dual-purpose proximity-impact fuze.

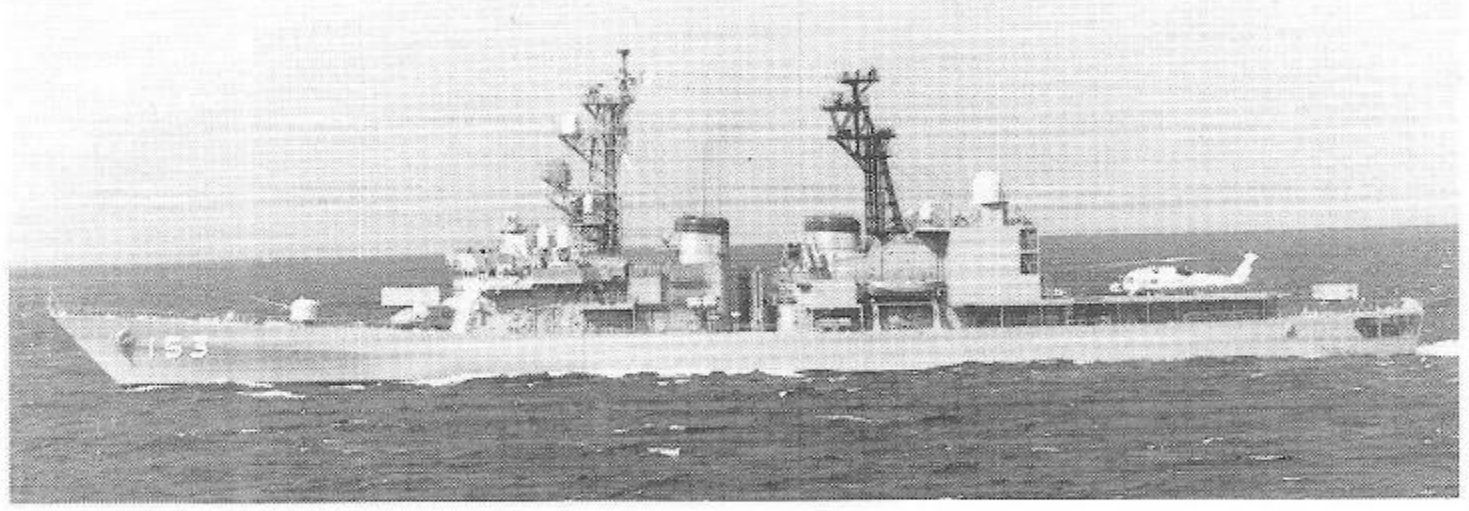
Specifications
(RIM-7M)
Length: 3.66 m (12.0 ft)
Diameter: 20.3 cm (8.0 in)
Wing span: 1.02 m (3.35 ft)
Weight: 226.8 kg (500 lb)
Speed: Mach 2.5
Range: 8 n miles (14.5 km)
Warhead (WAU-17/B): 38.6 kg (85.1 lb)
Guidance: Semi-active radar

Manufacturers/Contractors
Raytheon Company, Equipment Division (prime system contractor).
Raytheon Company, Missile Systems Division (prime missile contractor).
Hughes Missile Systems (second source missile).
Naval Weapons Center, Crane, USA (warhead).

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas RGM-84B Harpoon

Eight Harpoon anti-ship missile canisters are mounted immediately forward of the after stack; there are two groups of four launchers each, with each group pointing across the ship to the opposite beam. The missiles



Yuugiri *(DD 153). Weapons systems (from bow to stern) are: 76 mm gun; ASROC; Vulcan Phalanx CIWS (bridge wing); Harpoon (ahead of after stack); SH-60J LAMPS-III helicopter; Sea Sparrow SAM launcher (on quarterdeck). Large white dome on platform ahead of foremast (and above OPS-14C antenna) is the LAMPS-III datalink* (Hachiro Nakai)

are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options. One of these is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

There is a single Mk 112 launcher on the foredeck, with a magazine immediately behind it. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide

stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 460 m (1,500 ft).

When a submarine target is detected it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (197 and 1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (1,968 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and as they separate the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications

ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor

Honeywell Training and Control Systems, West Covina, California, USA.

TUBES

324 mm Type 68 (triple) torpedo launchers

Two Type 68 324 mm torpedo launchers, each consisting of three HOS 301 tubes, are sited amidships, one set on either beam. This is a US Mk 32 installation, manufactured under licence in Japan.

Specifications

Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

GUNS

OTOBREDA 76 mm (3 in)/62 Compact

There is one OTOBREDA 76 mm (3 in) gun sited in 'A' position on the foredeck.

Specifications

Calibre: 76.2 mm (3.0 in)
Length of barrel: 4.72 m (15.49 ft)
Elevation: −15 to +85°
Training speed: 70°/s
Elevation speed: 40°/s
Muzzle velocity: 900 m/s (2,953 ft/s)
Max rate of fire: 85 rds/min
Range: 8.6 n miles (16 km)

Manufacturer/Contractor

OTOBREDA, La Spezia, Italy.

Hughes Mk 15 CIWS Phalanx

There are two Hughes Mk 15 Phalanx close in weapons systems (CIWS) located either side of the after end of the bridge. The mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications

Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor

Hughes Missile Systems, Tucson, Arizona, USA (system).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

NEC NOLR-6C

(All except *Yamagiri.*) NOLR-6C is a radar intercept system, which was developed from the NOLR-5 in order to counter an anti-ship missile. It uses two rotating DF antennas to cover the main radar frequencies, with a circular dipole array mounted on the foretop to carry out direction-finding in the VHF and UHF bands. It uses electronic scanning. It is reported to be similar in many respects to the US Navy's AN/WLR-8.

OLR-9

***(Yamagiri* only.)** Only a few OLR-9 radar intercept systems appear to have been acquired by the JMSDF, one of which is installed in *Yamagiri* instead of NOLR-6. It is believed that OLR-9 is similar to the US Navy's AN/WLR-11, but no further details are available.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher

There are two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications

Launcher
Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Rounds
Diameter: 130 mm (5.1 in)
Length, weight:
Mk 182: 1,209 mm; 22.7 kg
Super Chaffstar: 1,209 mm; 20.9 kg
Super Gemini: 451 mm; 5.5 kg
Super Hiram III: 1,220 mm; 13.6 kg
Super Hiram IV: 467 mm; 3.8 kg
Super Loroc: 734 mm; 13.2 kg

Sawagiri *(DD 157)* (H & L van Ginderen Collection)

Manufacturers/Contractors
Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

Aerojet AN/SLQ-25 Nixie noisemaker
One AN/SLQ-25 Nixie (Phase 1), a solid-state, modular design electro-acoustic countermeasures decoy system is used to protect the ship from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter to generate and amplify the signals, a power-operated double-drum winch for streaming/ recovering the towed bodies, and a coaxial switching unit. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 488 m (1,600 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 95 cm long (3.10 ft), 15.24 cm (6 in) in diameter and weigh 18 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body is deployed at a time.

Manufacturer/Contractor
Aerojet ElectroSystems, Sacramento, California, USA.

OLT-3
All ships are fitted with the OLT-3 jammer.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

OYQ-6 action data automation
OYQ-6 is similar to the earlier OYQ-3 but has a UYK-20A computer and can exchange encrypted digital data over HF and UHF links.

COMMUNICATIONS AND DATALINKS

In addition to the normal communications, these ships have:
Link 11
Satcom
SQQ-28 helicopter datalink for SH-60J
Tacan: ORN-6.

WEAPONS CONTROL

Mitsubishi GFCS Model 2-12E/G
This is the weapons control system for Sea Sparrow. The associated radar operates in the I/J bands. The actual models installed are:
DD 151-154: Model 2-12E
DD 155-158: Model 2-12G

Mitsubishi GFCS Model 2-21A
There is one GFCS Model 2-21 (also known as the Type 79) system to control the fire of the 76 mm gun. The radar operates in the I/J band.

Manufacturer/Contractor
Mitsubishi Electric Corporation (MELCO), Tokyo, Japan.

RADARS

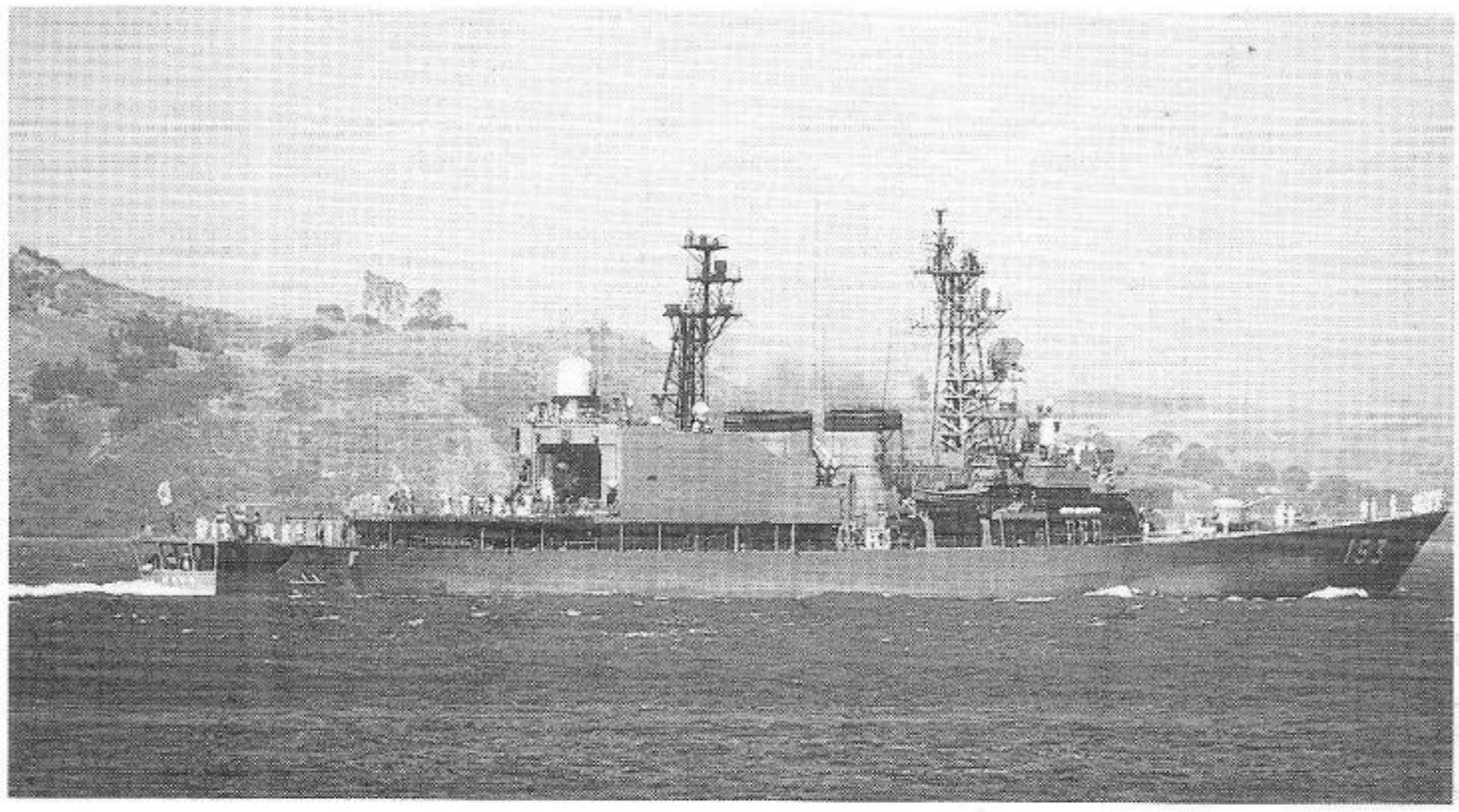
Mitsubishi OPS-14C
OPS-14C is a B/C-band air search radar. Peak power is 400 kW and beam width is 5°. It is installed only in DD 151-154.

Manufacturer/Contractor
Mitsubishi Electric Corporation (MELCO), Tokyo, Japan.

Mitsubishi OPS-24
OPS-24 is a new, planar array, 3D air search radar, which has replaced OPS-14C in DD 155-158. It operates in the D band.

Manufacturer/Contractor
Mitsubishi Electric Corporation (MELCO), Tokyo, Japan.

JRC OPS-28C
OPS-28 is a surface search and short-range air search radar, operating in the G and H bands. OPS-28 replaced OPS-17 and OPS-18.


Yuugiri (H & L van Ginderen Collection)

Manufacturer/Contractor
JRC, Tokyo, Japan.

SONARS

OQS-4A (II)
OQS-4A (II) is a Japanese-designed, improved version of the OQS-3, which was a licence-produced version of the US Navy's SQS-23. OQS-4A is a bow-mounted, active search and attack sonar, operating at medium frequencies.

OQR-1 (AN/SQR 18) TACTASS
TACTASS passive, low frequency towed array is being installed in place of the previous VDS system. Most ships are now fitted.

AVIATION

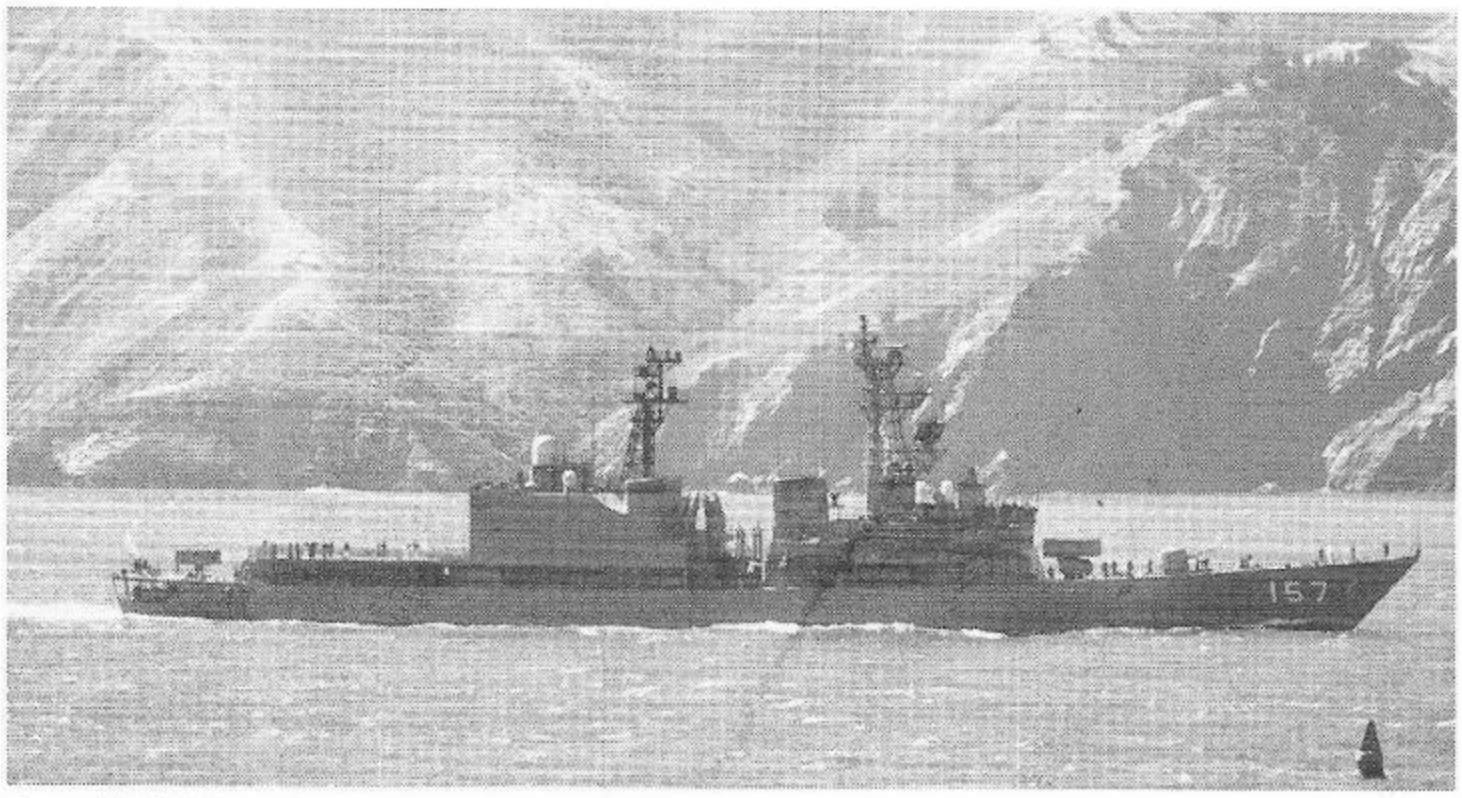
AVIATION FACILITIES

Specifications
Flight deck: 26 m × 14.6 m (85 × 48 ft)
Equipment: Indal Beartrap hauldown equipment

HELICOPTERS

Mitsubishi-Sikorsky SH-60J Seahawk
The class originally operated one Mitsubishi/Sikorsky HSS-2B Sea King but this has now been replaced by the SH-60J.

Specifications
Main rotor:
diameter: 16.36 m (53.66 ft)
disc area: 210.15 m² (2,262 sq ft)
Tail rotor:
diameter: 3.35 m (11.00 ft)
disc area: 8.83 m² (95.03 sq ft)


Sawagiri (H & L van Ginderen Collection)

Length overall:
fuselage: 15.26 m (50.0 ft)
rotors turning: 19.76 m (64.83 ft)
Height overall, tail rotor turning: 5.18 m (17.0 ft)
Weight empty: 6,191 kg (13,648 lb)
Mission gross weight: 9,182 kg (20,244 lb)
Dash speed at 1,525 m (5,000 ft), tropical day: 126 kts (234 km/h)
Vertical rate of climb at S/L, 32.2°C (90°F): 213 m (700 ft)/min
Power plant: 2 General Electric T700-GE-401 turboshafts rated at 1,260 kW (1,690 shp) 1,342 kW (1,800 shp)
Accommodation: 3 (pilot and airborne tactical officer/back-up pilot in cockpit, sensor operator in specially equipped station in cabin)
Radar: Japanese HPS-104 search radar
Flight: Japanese automatic flight management system and ring laser gyro AHRS
Instrumentation: Japanese controls and displays subsystem, datalink and tactical data processor
Mission: Japanese HQS-103 sonar; Texas Instruments AN/ASQ-81D2(V) MAD; Ednac AN/ARR-75 sonobuoy receiver
Self-defence: General Instruments AN/ALR-66 (VE) RWR; Japanese HLR-108 ESM
Armament: 2 Mk 46 torpedoes or depth bombs

Mitsubishi/Sikorsky SH-60J Seahawk aboard Yamagiri *(DD 152). Note the trolley underneath the helicopter and the tracks leading to the hangar for the Indal Beartrap hauldown and deck handling system* (Hachiro Nakai)

PROPULSION

Specifications

System: Combined gas and gas (COGAG)
Main machinery: 4 Rolls-Royce Spey SM1A gas-turbines; 39.8 MW (53,300 hp) sustained

Shafts: 2
Propellers: cp

FURTHER INFORMATION

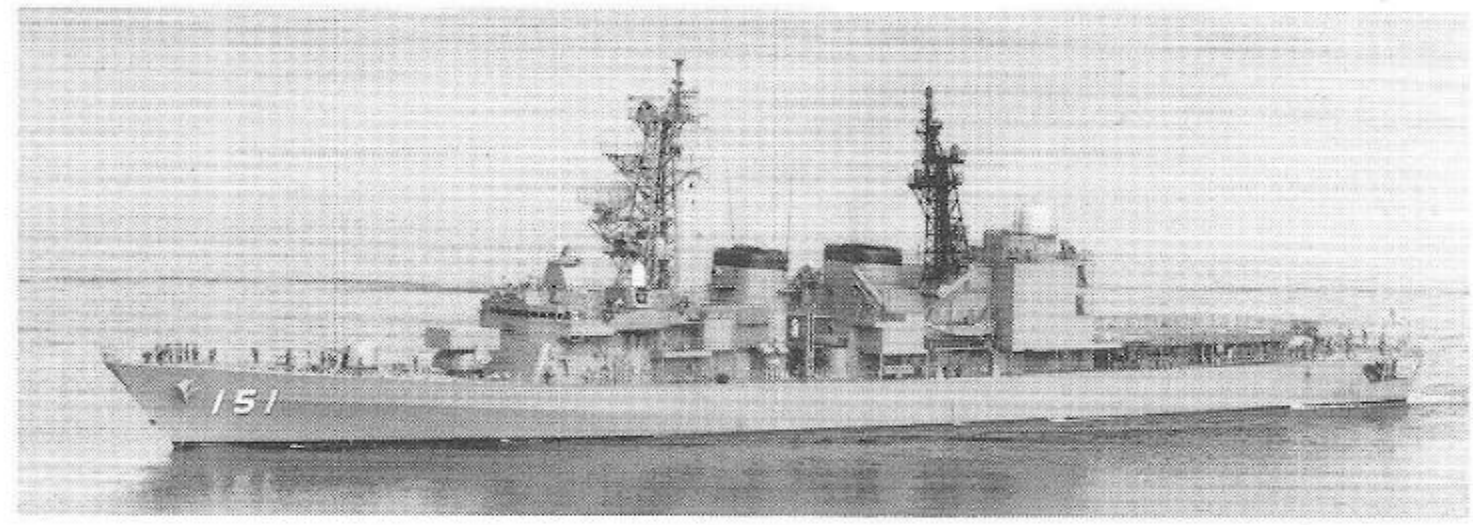
PROGRAMME

The 'Asagiri' class was originally known as the 'Improved Hatsayuki' class, which it closely resembles. DD 151 was approved in the 1983 estimates, followed by DD 152-154 in 1984, DD 155-157 in 1985 and DD 158 in 1986. The first joined the fleet in 1988 and the last in 1991.

DESIGN

These ships are essentially improved Hatsuyukis with the alterations mainly concerning the propulsion system. The 'Hatsuyuki' class had a COGOG system comprising two Olympus and two Tynes, but in the 'Asagiri' class there are four Olympus in a COGAG arrangement. The Speys are paired in a unit arrangement with the stacks *en echelon,* as in the US Navy's 'Spruance' class, the forward stack offset to port and the after funnel to the starboard side of the superstructure. The hangar structure is asymmetric, extending to the after funnel on the starboard side but only to the mainmast to port. The large flightdeck is at 01 deck level and is fitted with an Indal Beartrap hauldown device.

Satcom antennas are installed at the foot of the foremast.



Asagiri *(DD 151), nameship of a class of eight destroyers* (Hachiro Nakai)

Setogiri *(DD 156)* (H & L van Ginderen Collection)

MODERNISATION

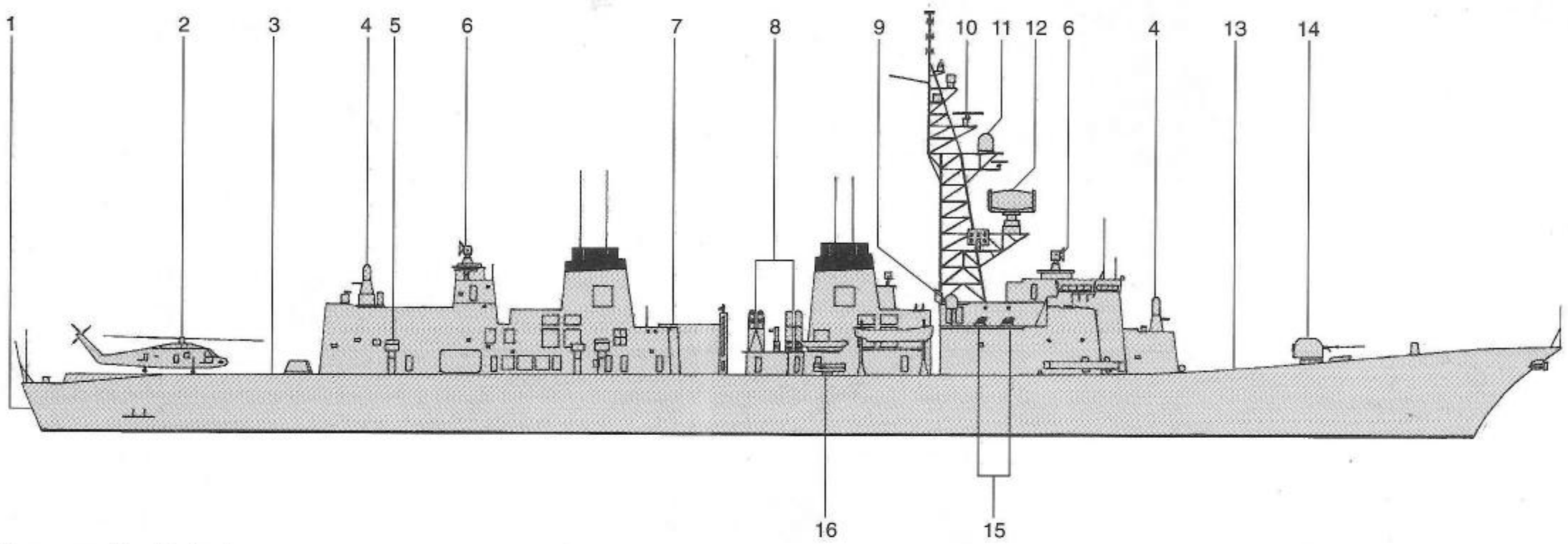
Once in service, several problems were discovered concerning the efflux from the more powerful gas-turbines. First, they generated an enhanced IR signature and, secondly, the gasses from the after stack were causing damage to the electronic systems on the mainmast. Modifications have been made to help contain the problem, with the mainmast being raised slightly compared to the original design and offset more to port.

The last four of the class (DD 155 onwards) have been fitted on build with improved air search radar, updated fire-control radars and a helicopter datalink. The eighth and last ship, *Umigiri* (DD 158) also commissioned with a sonar towed array which has since been fitted to the rest of the class. Other improvements are always being incorporated, of which one of the most significant is the replacement of the HSS-2B Sea King by the SH-60J Seahawk and the fitting of the associated SQQ-28 datalink.

DEPLOYMENT

These ships are normally assigned to:
1st Escort Flotilla (Yokosuka): *Asagiri* (DD 151); *Yamagiri* (DD 152); *Sawagiri* (DD 157)
2nd Escort Flotilla (Sasebo): *Yugiri* (DD 153); *Amagiri* (DD 154); *Hamagiri* (DD 155); *Setogiri* (DD 156); *Umigiri* (DD 158).

MURASAME



Murasame (Ian Sturton)
1 *SLQ-25 Nixie torpedo decoy* **2** *SH-60J Seahawk helicopter* **3** *Flight deck* **4** *Mk 15 Vulcan Phalanx 20 mm CIWS* **5** *Hangar* **6** *Type 2-31 fire control* **7** *Raytheon Mk 48 16-cell VLS (Sea Sparrow SAM)* **8** *Harpoon launcher-container (eight missiles)* **9** *Satcom* **10** *JRC OPS-28D radar (surface search)* **11** *SQQ-28 LAMPS-III datalink* **12** *MELCO OPS-24 radar (air search)* **13** *Mk 41 VL ASROC (16 cells; 29 missiles)* **14** *OTOBREDA 76 mm (3 in) Compact mounting* **15** *Chaff launchers* **16** *Mk 32 324 mm triple torpedo launchers*

GENERAL SPECIFICATIONS

Operator: Japan

Class: MURASAME

Active: 1
Building: 5
Proposed: 2

Displacement:
standard: 4,400 t
full load: 5,100 t

Dimensions
Length: 151 m (495.5 ft)
Beam: 17.4 m (57.1 ft)
Draught: 5.2 m (17.1 ft)

Speed: 30 kts

Complement: 170

SHIPS

MURASAME (DD 101)

Builder	Ishikawajima Harima, Tokyo, Japan
Laid down	18 Aug 1993
Launched	23 Aug 1994
Commissioned	Mar 1996

HARUSAME (DD 102)

Builder	Mitsui, Tamano, Japan
Laid down	24 Aug 1994
Launched	16 Oct 1995
Commissioned	Mar 1997

(DD 103)

Builder	Sumitomo, Uraga, Japan
Laid down	Apr 1996
Launched	Sep 1997
Commissioned	Mar 1999

(DD 104)

Builder	Mitsubishi, Nagasaki, Japan
Laid down	Apr 1996
Launched	Aug 1997
Commissioned	Mar 1999

(DD 105)

Builder	—
Laid down	Apr 1997
Launched	Aug 1998
Commissioned	Mar 2000

(DD 106)

Builder	—
Laid down	Apr 1997
Launched	Aug 1998
Commissioned	Mar 2000

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Mitsubishi Type 87 (SSM-1B) surface-to-surface missile

The 'Murasame' class is the first to be armed with the Japanese-designed SSM-1B ship-launched missile, with eight launchers in two groups of four immediately abaft the forward engine uptakes. SSM-1B is a naval development of the SSM-1 coastal defence missile, powered by a Mitsubishi TJM 2 turbojet, with a tandem solid propellant rocket booster for launch. The folding aerodynamic surfaces consist of delta planform wings and an X-configured, in-line tail. The missile uses the Harpoon's AN/SWG-1A fire-control system and from the appearance of the launch containers, it uses Harpoon containers, as well. Missile operation is reported to be similar to that of Harpoon with the missile quickly adopting a low-level cruising altitude until the seeker has acquired the target then dropping to a sea-skimming height for the terminal phase.

Specifications
Length: 5.08 m (16.66 ft)
Diameter: 34 cm (13.38 in)
Launch weight: 660 kg (1,445 lb)
Warhead: 225 kg (496 lb) (semi-armour-piercing)
Speed: Mach 0.9
Range: 80 n miles (150 km)
Guidance: Inertial with active radar

Manufacturer/Contractor
Mitsubishi Heavy Industries, Tokyo, Japan.

Raytheon Sea Sparrow point-defence missile system

Sea Sparrow is installed in a 16-cell, Mk 48 vertical launch system between the two engine uptakes, using RIM-7 Sea Sparrow missiles. The system uses the Mitsubishi Type 2-31 fire-control system, with two directors. The system is fully automatic from target acquisition to interception. The Sea Sparrow missile, although based upon the air-to-air Sparrow, has been enhanced for launching from ships, and has a 38.6 kg blast fragmentation warhead and a dual-purpose proximity-impact fuze.

Specifications
(RIM-7M)
Length: 3.66 m (12.0 ft)
Diameter: 20.3 cm (8.0 in)
Wing span: 1.02 m (3.35 ft)
Weight: 226.8 kg (500 lb)
Speed: Mach 2.5
Range: 8 n miles (14.5 km)
Warhead (WAU-17/B): 38.6 kg (85.1 lb)
Guidance: Semi-active radar

Manufacturers/Contractors
Raytheon Company, Equipment Division (prime system contractor).
Raytheon Company, Missile Systems Division (prime missile contractor).
Hughes Missile Systems (second missile source).
Naval Weapons Center, Crane, USA (warhead).

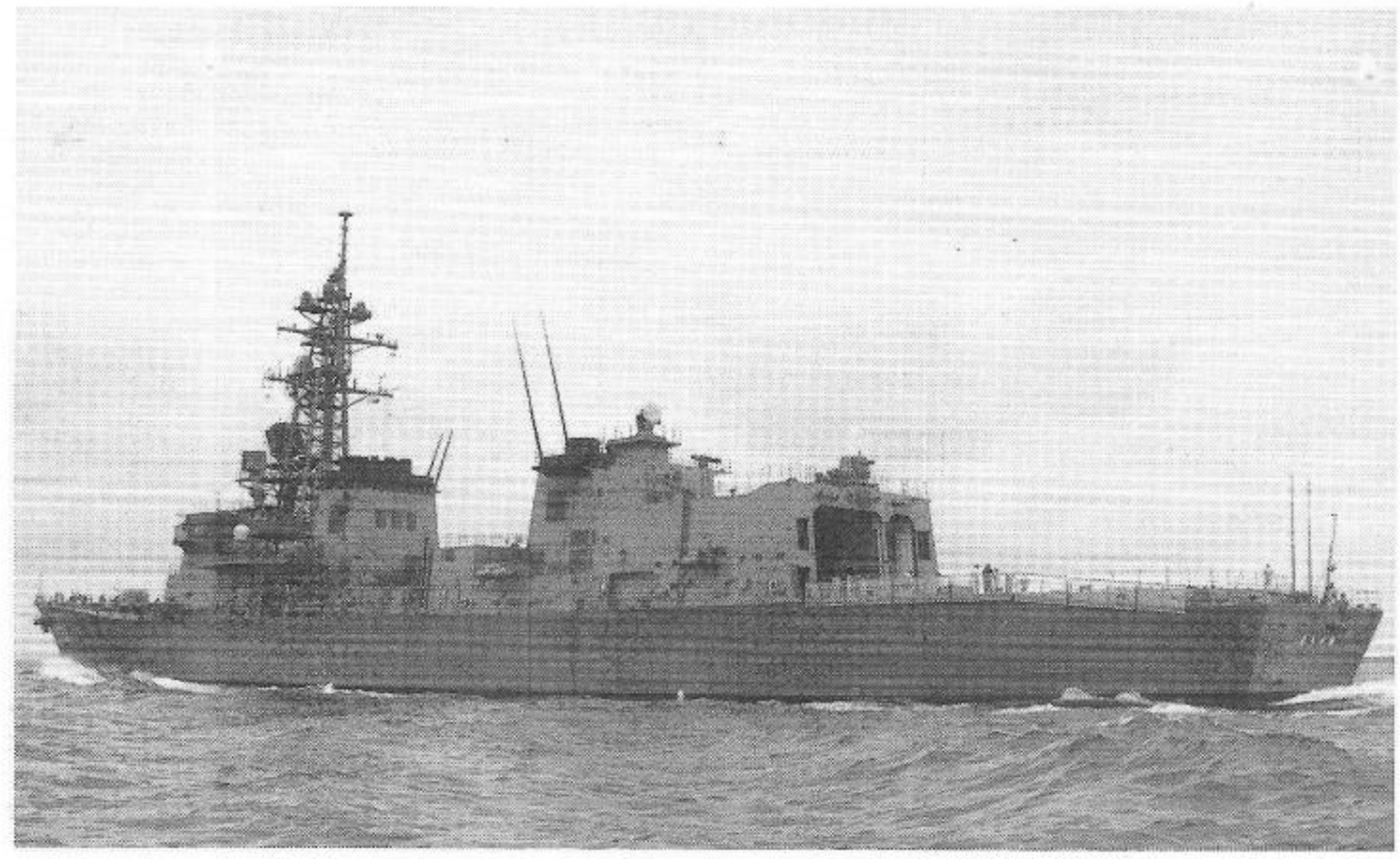
ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

There are 16 ASROC missiles in a Mk 41 vertical launcher in the foredeck. ASROC consists of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction,

held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 460 m (1,500 ft).

When a submarine target is detected it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (197 and 1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (1,968 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and as they separate the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.



The 'Murasame' class destroyers are large and well-armed. Weaponry includes Japanese-designed SSM-1B missiles, Sea Sparrow, ASROC, 76 mm gun, two CIWS, six ASW torpedo launchers and the LAMPS-III ASW helicopter system (Hachiro Nakai)

Specifications
ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor
Honeywell Training and Control Systems, West Covina, California, USA.

TUBES

324 mm Type 68 (triple) torpedo launchers
Two Type 68 324 mm torpedo launchers, each consisting of three HOS 301 tubes, are sited amidships, one set on either beam. This is a US Mk 32 installation, manufactured under licence in Japan.

Specifications
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

GUNS

OTOBREDA 76 mm (3 in)/62 Compact
There is one OTOBREDA 76 mm (3 in) gun sited in 'A' position on the foredeck.

Specifications
Calibre: 76.2 mm (3.0 in)
Length of barrel: 4.72 m (15.49 ft)
Elevation: −15 to +85°
Training speed: 70°/s
Elevation speed: 40°/s
Muzzle velocity: 900 m/s (2,953 ft/s)
Max rate of fire: 85 rds/min
Range: 8.6 n miles (16 km)

Manufacturer/Contractor
OTOBREDA, La Spezia, Italy.

Hughes Mk 15 CIWS Phalanx
There are two Hughes Mk 15 Phalanx close in weapons systems (CIWS); one is located on a platform immediately before the bridge, the other on the hangar roof aft. The mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications
Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor
Hughes Missile Systems, Tucson, Arizona, USA (systems).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

NEC NOLQ-2
NOLQ-2 is a new ECM intercept and jamming equipment.

DECOYS

Four chaff launchers.

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher
There are two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications
Launcher
Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Rounds
Diameter: 130 mm (5.1 in)
Length, weight:
Mk 182: 1,209 mm; 22.7 kg
Super Chaffstar: 1,209 mm; 20.9 kg
Super Gemini: 45 mm; 5.5 kg
Super Hiram III: 1,220 mm; 13.6 kg
Super Hiram IV: 467 mm; 3.8 kg
Super Loroc: 734 mm; 13.2 kg

Manufacturers/Contractors
Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

Aerojet AN/SLQ-25 Nixie noisemaker
One AN/SLQ-25 Nixie (Phase 1), a solid-state, modular design electro-acoustic countermeasures decoy system is used to protect the ship from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 488 m (1,600 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 95 cm long (3.10 ft), 15.24 cm (6 in) in diameter and weigh 18 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body is deployed at a time.

Manufacturer/Contractor
Aerojet ElectroSystems, Sacramento, California, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

OYQ-7
OYQ-7 is the latest JMSDF combat data system.

COMMUNICATIONS AND DATALINKS

Link 11.

RADARS

Mitsubishi OPS 24
OPS-24 is a new, planar array, 3D air search radar, which has replaced OPS-14C in DD 155-158. It operates in the D band.

Manufacturer/Contractor
Mitsubishi Electric Corp (MELCO), Tokyo, Japan.

JRC OPS-28
OPS-28 is a surface search and short-range air search radar, operating in the G and H bands.

Fire-control radars
There are two Type 2-31 installations: one is on the bridge roof, the other aft on the hangar roof. This appears to be a combined system for both missiles and the gun.

OPS-20
There is one OPS-20, I-band, navigation radar.

Murasame *(DD 101) lead ship of a class of eight and one of the most sophisticated destroyers in the world. It is smaller than the 'Kongo' class and lacks the Aegis system but is considerably cheaper, which has become important as the Kongo programme has been reduced to four ships on the grounds of cost* (Hachiro Nakai)

SONARS

Mitsubishi OQS-5
OQS-5 is a new, hull-mounted, active search and attack sonar, operating at low frequency.

Manufacturer/Contractor
Mitsubishi Electronic Corporation, (MELCO), Tokyo, Japan.

OQR-1 (AN/SQR 18) TACTASS
TACTASS passive, low-frequency towed array is installed.

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 40 × 17 m (130 × 56 ft) (approx)
Handling gear: Indal RAST

HELICOPTER

Mitsubishi-Sikorsky SH-60J Seahawk
The class operates one Mitsubishi/Sikorsky SH-60J Seahawk.

Specifications
Main rotor:
diameter: 16.36 m (53.66 ft)
disc area: 210.15 m² (2,262 sq ft)
Tail rotor:
diameter: 3.35 m (11.00 ft)
disc area: 8.83 m² (95.03 sq ft)
Length overall:
fuselage: 15.26 m (50.0 ft)
rotors turning: 19.76 m (64.83 ft)
Height overall, tail rotor turning: 5.18 m (17.0 ft)
Weight empty: 6,191 kg (13,648 lb)
Mission gross weight: 9,182 kg (20,244 lb)
Dash speed at 1,525 m (5,000 ft), tropical day: 126 kts (234 km/h)
Vertical rate of climb at S/L, 32.2°C (90°F): 213 m (700 ft)/min
Power plant: 2 General Electric T700-GE-401 turboshafts rated at 1,260 kW (1,690 shp) 1,342 kW (1,800 shp)
Accommodation: 3 (pilot and airborne tactical officer/back-up pilot in cockpit, sensor operator in specially equipped station in cabin)
Radar: Japanese HPS-104 search radar
Flight: Japanese automatic flight management system and ring laser gyro AHRS
Instrumentation: Japanese controls and displays sub-system, datalink and tactical data processor
Mission: Japanese HQS-103 sonar; Texas Instruments AN/ASQ-81D2(V) MAD; Ednac AN/ARR-75 sonobuoy receiver
Self-defence: General Instruments AN/ALR-66 (VE) RWR; Japanese HLR-108 ESM
Armament: 2 Mk 46 torpedoes or depth bombs

PROPULSION

Specifications
System: Combined gas and gas (COGAG)
Main machinery: 2 Rolls-Royce Spey SM1C gas-turbines; 31 MW (41,630 hp) sustained; 2 General Electric LM-2500 gas-turbines; 32.08 MW (43,000 hp) sustained
Shafts: 2

FURTHER INFORMATION

PROGRAMME

Approval has so far been obtained for six of these ships: FY91 (1); FY92 (1); FY94 (2); FY95 (1) and FY96 (1). The plan is, however, to achieve a class of eight, giving two in each escort flotilla. The programme has been given added priority as a consequence of the reduction of the 'Kongo' class from six to four ships, due to the very high costs of the Aegis system.

DESIGN

Although in sequence these ships are the follow-on to the 'Asagiri' class, the design appears to be more like a smaller *Kongo* than an enlarged *Asagiri.* Like the *Kongo,* the *Murasame* has a forward VLS system, but the after VLS launcher has been omitted to create space for the helicopter flight deck and hangar.

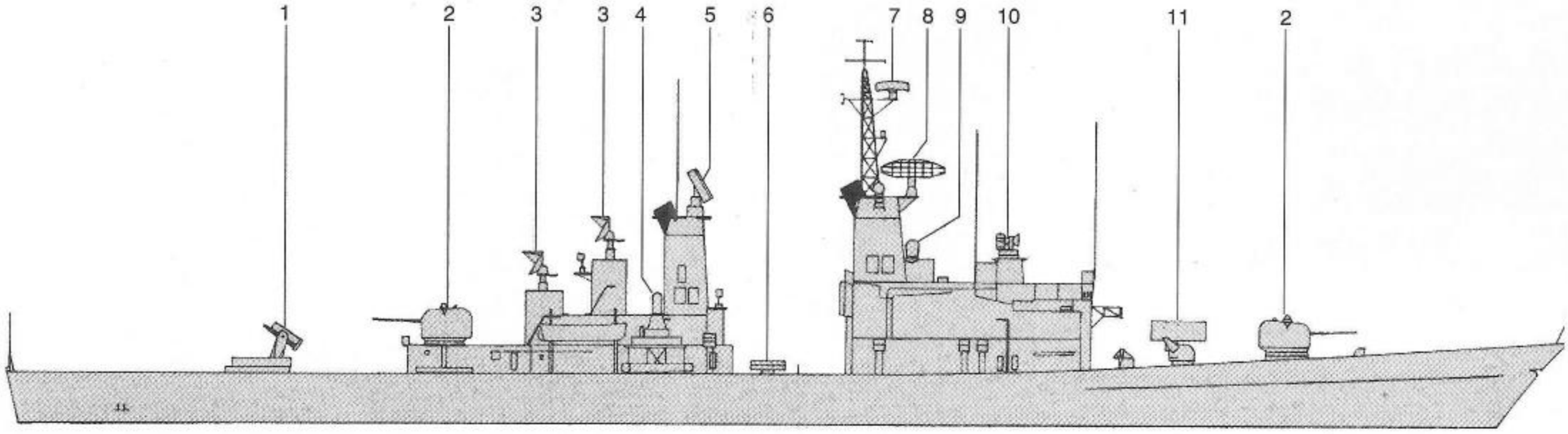
A variety of stealth features are apparent, including IR filters on the engine uptakes, and careful avoidance of vertical sloping sides to most structures.

One feature of the design is that the propulsion system combines two Rolls-Royce Speys with two General Electric LM-2500s, the first time that the products of these two rivals have been combined in the same engine-room.

DEPLOYMENT

The first two ships to be commissioned, *Murasame* (DD 101) and *Harusame* (DD 102), have been assigned to the 1st Escort Flotilla (Yokosuka) and the remaining six ships will be allocated in pairs to the other three flotillas.

TACHIKAZE



Tachikaze (Ian Sturton)
1 *Mk 13 Mod 3/4 single-arm launcher (Harpoons and Standard)* **2** *127 mm (5 in)/54 Mk 52 automatic gun mounting (single)* **3** *Raytheon SPG-51 fire-control radar (Standard SAM)* **4** *Mk 15 Vulcan Phalanx 20 mm CIWS* **5** *Hughes SPS-52B/C radar (air search)* **6** *Mk 32 324 mm triple torpedo launcher* **7** *JRC OPS-16 radar (surface search)* **8** *MELCO OPS-11 radar (air search)* **9** *Satcom* **10** *Type 2 fire-control system* **11** *Mk 112 ASROC eight-cell launcher*

GENERAL SPECIFICATIONS

Operator: Japan

Class: TACHIKAZE

Built: 3
Active: 3

Displacement:
standard:
Tachikaze (DD 168), Asakaze (DD 169): 3,850 t
Sawakaze (DD 170): 3,950 t
full load: 4,800 t

Dimensions
Length: 143 m (469 ft)
Beam: 14.3 m (47 ft)
Draught: 4.7 m (15.4 ft)

Speed: 32 kts

Complement:
Tachikaze (DD 168), Asakaze (DD 169): 250
Sawakaze (DD 170): 255

SHIPS

TACHIKAZE (DD 168)

Builder	Mitsubishi, Nagasaki, Japan
Laid down	19 Jun 1973
Launched	17 Dec 1974
Commissioned	26 Mar 1976

ASAKAZE (DD 169)

Builder	Mitsubishi, Nagasaki, Japan
Laid down	27 May 1976
Launched	15 Oct 1977
Commissioned	27 Mar 1979

SAWAKAZE (DD 170)

Builder	Mitsubishi, Nagasaki, Japan
Laid down	14 Sep 1979
Launched	4 Jun 1981
Commissioned	30 Mar 1983

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas RGM-84B Harpoon

Harpoon anti-ship missiles share the 40-round magazine with the Standard missiles and are launched from the same Mk 13 launcher. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options. One of these is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Asakaze (DD 169). When the JMSDF installed Harpoon missiles in these ships it decided not to mount launcher-containers on the deck (although there would have been more than sufficient space) and instead put them in the missile magazine aft, thus displacing an equal number of Standard SM-1MR. Note that at the time this picture was taken the Vulcan Phalanx CIWS had not yet been fitted (H & L van Ginderen Collection)

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

SURFACE-TO-AIR MISSILE (SAM)

Standard Missile-1 Medium Range (SM-1MR)

Main air defence armament is the SM-1MR which is launched from the Mk 13 Mod 3/4 launcher on the quarterdeck. The below deck magazine holds 40 missiles, but this number also includes Harpoon SSMs (see above). When the target is detected the data is evaluated by the ship's command system and the target is designated for the missile fire-control system, which then tracks and illuminates it. Each SPG-51C tracker/illuminator radar usually controls one missile. Once the missile is launched, the tracker's main illumination beam holds the target while the rear reference illuminator beam provides guidance data through the missile's rear reference antenna. This guides the missile until the onboard seeker detects the CW reflected energy from the main illuminator beam. The onboard guidance system then brings the missile to an interception course. SM-1MR Block IV missiles have a Naval Weapon Center Mk 51 expanding rod warhead, while Block V missiles have a Naval Weapon Center Mk 90 blast fragmentation warhead.

Specifications
Length: 4.48 m (14.7 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.06 m (3.48 ft)
Weight: 642.3 kg (1,416 lb)
Speed: Mach 2
Range: 20.5 n miles (38 km)
Altitude: 19,800 m (65,000 ft)

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA.
Raytheon, Missile Systems Division, Bedford, Maryland, USA.

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

There is a single Mk 112 launcher on the foredeck, between the bridge and the 'B' position gun mounting. A magazine with reloads is fitted in *Sawkaze* (DD 170) only. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal

Tachikaze *(DD 168)* (H & L van Ginderen Collection)

aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 460 m (1,500 ft).

When a submarine target is detected it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (197 and 1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (1,968 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and as they separate the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications
ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

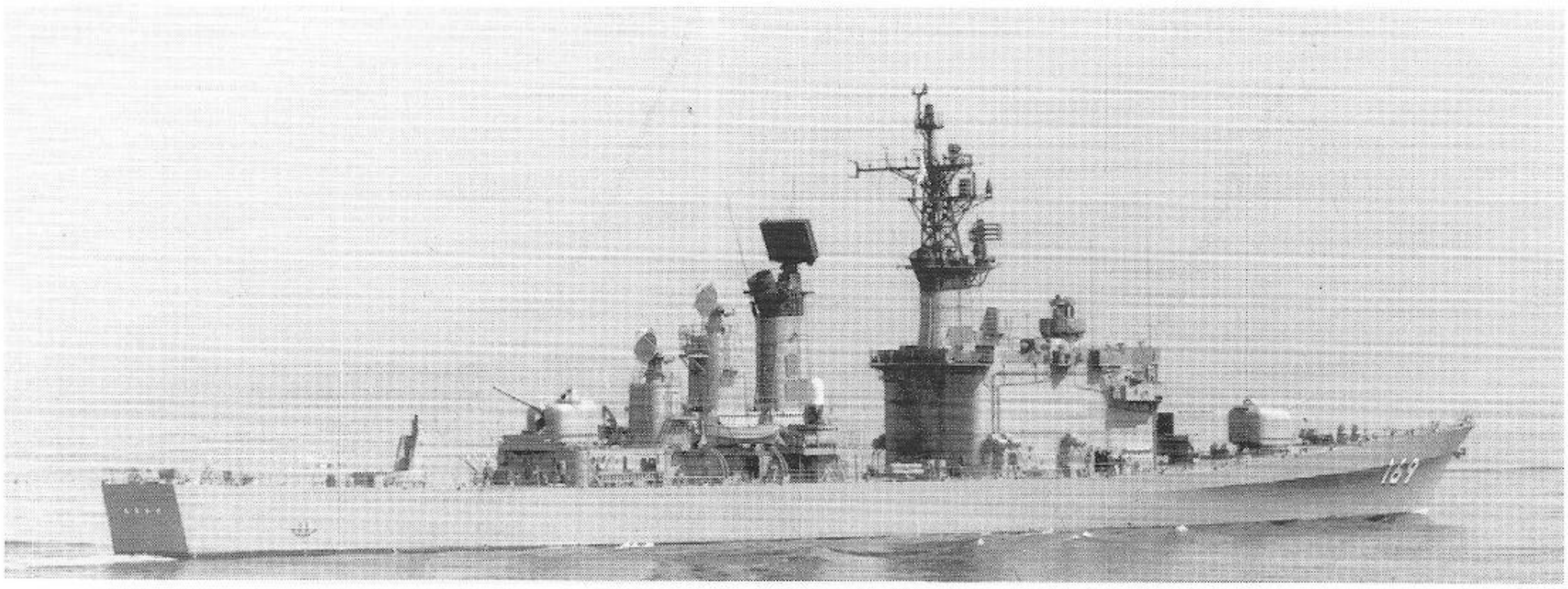
Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor
Honeywell Training and Control Systems, West Covina, California, USA.

TUBES

Two triple 324 mm Type 68 torpedo tubes are sited amidships, underneath the boat davits, one on either beam. The Type 68 is the US Mk 32 design, manufactured under licence in Japan.

Specifications
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)



Asakaze *(DD 169) after the fitting of Mk 15 Vulcan Phalanx CIWS abreast the after mack. The large box to the right of the forward mack would appear to be an ECM device, possibly the OLT-3* (Hachiro Nakai)

TORPEDOES

Alliant Techsystems Mk 46 Mod 5 (Neartip) 324 mm torpedoes

Specifications
Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

Manufacturer/Contractor
Alliant Techsystems, Mukilteo, Washington, USA.

GUNS

United Defense Mk 42 Single 127 mm (5 in)/54 gun mounting
The two Mk 42 mountings each house a single Mk 18 127 mm/54 gun and are located in 'A' on the foredeck and in 'Y' position aft. The Mk 18 gun has a two-piece barrel with replaceable liner and a service life of some 2,000 rounds. A bayonet-type joint attaches the gun to the housing which includes a vertical sliding breech block and the entire gun assembly is supported on rollers in the slide. A separate rammer is mounted on the slide.

The Mk 42 mounting was introduced in 1953 and was produced in Japan under licence. The upper part of the mounting is fully power driven and is enclosed in an armoured shield. The Mk 42 mounting requires a crew of 12: four men within the shield and eight in the magazine and ammunition handling system.

Ammunition is loaded by a dual system with projectiles supplied automatically to the slide alternately from the right and left. The loading system consists of two manually loaded drums, one with 20 projectiles and the other with 20 charges, which rotate to bring the projectile and cartridge together. Complete rounds are lifted from the lower hoist to the upper hoist and from there to the cradles which move them to the tray from where they are rammed into the breech.

Magazine capacity is 550 rounds and ammunition includes the Mk 41 AAC/HC, Mk 42 common, and Mk 48 illumination rounds, all of which weigh 31.75 kg. All rounds have point detonating, proximity or mechanical time fuzes.

Specifications
Gun, 127 mm/54 Mk 18
Calibre: 127 mm (5 in)
Length of barrel: 54 calibres
Muzzle velocity:
new barrel: 807 m/s (2,650 ft/s)
mid-life: 792 m/s (2,600 ft/s)
Max range: 12 n miles (22 km)
Max altitude: 14,400 m (47,000 ft)
Ammunition: 31.75 kg (70 lb)

Mounting, Mk 42
Traverse: 360° at 40°/s
Elevation: −15 to +85° at 25°/s
Rate of fire: 20-40 rds/min

Manufacturer/Contractor
United Defense Armaments Systems Division, Minneapolis, Minnesota, USA.

Hughes Mk 15 CIWS Phalanx
There are two Hughes Mk 15 Phalanx close in weapons system (CIWS) situated either side of the after mack. The mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications
Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor
Hughes Missile Systems, Tucson, Arizona, USA (systems).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

NEC NOLR-6C
***(Tachikaze* (DD 168) only.)** NOLR-6C is a radar intercept system, which was developed from the NOLR-5 in order to counter anti-ship missiles. It uses two rotating DF antennas to cover the main radar frequencies, with a circular dipole array mounted on the foretop to carry out direction-finding in the VHF and UHF bands. It uses electronic scanning. It is reported to be similar in many respects to the US Navy's AN/WLR-8.

Mitsubishi NOLQ-1
***(Asakaze* (DD 169); *Sawakaze* (DD 170).)** NOLQ-1 is the standard JMSDF intercept/jammer and is reported to be very similar to the Raytheon AN/SLQ-32(V)3 (Sidekick).

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher
There are two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications
Launcher
Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Rounds
Diameter: 130 mm (5.1 in)
Length, weight:
Mk 182: 1,209 mm; 22.7 kg
Super Chaffstar: 1,209 mm; 20.9 kg
Super Gemini: 451 mm; 5.5 kg
Super Hiram III: 1,220 mm; 13.6 kg
Super Hiram IV: 467 mm; 3.8 kg
Super Loroc: 734 mm; 13.2 kg

Manufacturers/Contractors
Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

Fujitsu OLT-3
All ships are fitted with the OLT-3 jammer.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Each ship is fitted with a different combat data system:
Tachikaze (DD 168) — OYQ-1B
Asakaze (DD 169) — OYQ-2B
Sawakaze (DD 170) — OYQ-4

COMMUNICATIONS AND DATALINKS

Link 11
Link 14
Satcom
IFF: US Mk 10.

WEAPONS CONTROL

Raytheon Mk 74 Mod 13 for Standard
All three ships each have two Mk 74 Mod 13 fire-control systems for the Standard SM-1MR missiles. The Mk 74 system acquires, tracks and illuminates targets which it has been assigned by the OYQ-4 system. Mk 74 is not involved in the launch sequence, but takes over after missile launch, when it monitors the missile and controls it until interception of the target; it then carries out a post-launch evaluation.

All Mk 74 systems consist of an AN/SPG-51C G/H-I/J-band radar, a Mk 73 director and associated consoles, but the Mod 13 does not use a computer, using a CV 3432 radar data processor instead. The SPG-51C has two independent channels each with a G/H-band tracking radar and an I/J-band illumination transmitter. This radar has longer detection and acquisition ranges than its predecessor, and automatic target scheduling, which require fewer operator decisions. The Mk 73 director is a rotating electronic structure which includes the transmitter group, the control power supply for CW injection, the power supply for the pulse Doppler system, and a radar data converter. It can traverse up to 360° while elevation limits are −30 to +83°.

Manufacturer/Contractor
Raytheon Electronic Systems, Portsmouth, Rhode island, USA.

Loral Mk 114 ASW fire-control system
The Singer Mk 114 is the fire-control system for ASW operations. The main element is the Mk 53 Attack Console, an electromechanical analogue system which consists of two major units, the attack plotter and the ballistic computer. The latter conducts weapon presets for both ASROC and ASW torpedoes. The Mk 114 system also includes the Mk 33 underwater fire-control switchboard which accepts data from two Mk 19 gyrocompasses and other sensors, as well as from the Mk 134 sonar stabilisation computer. The consoles have an AN/UYK-44 reconfigurable processor with some 70,000 lines of CMS-2 language code.

The Mk 114 interfaces with the sonars: in this case, the EDO/NEC SQS-35(J) VDS, the bow-mounted NEC OQS-101; and the EDO/NEC SQR-18A towed array.

Manufacturer/Contractor
Loral Librascope, Glendale, California, USA.

Mitsubishi GFCS Model 2-21
Sawakaze (DD 170) has a Mitsubishi Electric GFCS Model 2-21 (also known as the Type 79) to control the fire of the two guns. It operates in the I/J bands.

Manufacturer/Contractor
Mitsubishi Electric Corp (MELCO), Tokyo, Japan.

GFCS Model 1A
Tachikaze (DD 168) and *Asakaze* (DD 169) have a GFCS Model 1A gunfire control system (also known as the Type 72).

Tachikaze *(DD 168) has a characteristically Japanese huge square bridge structure and the macks (combined mast and stack) which were in vogue in some designs of the era such as the US Navy's 'Belknap' class. The individual towers for the SPG-51s are also apparent* (Hachiro Nakai)

RADARS

Mitsubishi OPS 11C

OPS-11C is a Japanese-designed, long-range, air-search radar, operating in the B, C and D bands. OPS-11B operates at 300 MHz (B band).

Hughes SPS-52C, 3D

Specifications
(In *Sawakaze* (DD 170) only)
Role: long-range air search
Frequency: E/F band
Range: 240 n miles (440 km)
Beam: 1.1 × 2.25°
Peak power: 1,000 kW
Gain: 39.5 dB
Pulsewidth: 2.5/4.6/10 µs
PRF: 1,850/925 pps
Scan rate: 15/6 rpm

JRC OPS 16

OPS-16 is a surface-search radar, operating in the D band.

JRC OPS 28C/D

OPS-28 is a surface search and short-range air search radar, operating in the G and H bands. It is currently fitted only in *Sawakaze* (DD 170) but as it is now the standard destroyer set, it will probably be fitted in the two earlier ships in due course.

SONARS

OQS-3A

OQS-3A (also known as the Type 66) is a licence-built version of the US Navy's AN/SQS-23 bow sonar. The latter is a late 1950s, bow-mounted, active, search and attack sonar, operating at medium frequency (5 kHz).

PROPULSION

Specifications
System: Steam turbines
Main machinery: 2 Mitsubishi boilers; 60 kg/cm² (600 psi); 454°C (850°F); 2 Mitsubishi turbines; 51.5 MW (70,000 hp (m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The 'Tachikaze' class was an enlarged and better armed version of the 'Amatsukaze' class, and also introduced a much larger Japanese content, particularly in electronic equipment.

Three were built, joining the fleet between 1976 and 1983, with three years between the first and second ships, and four years between the second and third, a programme that was rather slow by Japanese standards. Indeed, the building rate has been so slow that numerous changes were implemented in the second and third during construction. All three have undergone one modernisation, which may be followed by a more major, mid-life rebuild.

DESIGN

As built, the 'Tachikaze' class had a single launcher for Standard SM-1MR missiles aft, an eight-cell Mk 116 launcher for ASROC before the bridge, two 127 mm (5 in)/54 Mk 42 mounts and two three-tube Type 68 torpedo launchers.

The 'Tachikaze' class uses exactly the same propulsion system as the 'Haruna' class, comprising two Mitsubishi boilers and two Mitsubishi steam turbines.

MODERNISATION

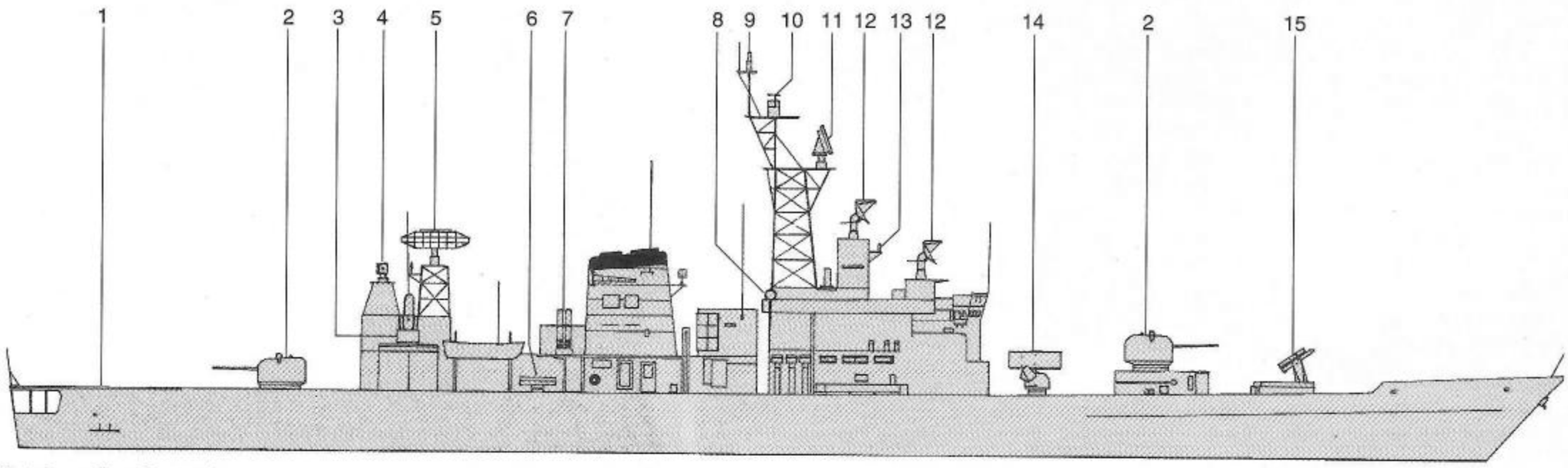
Harpoon and CIWS were added to DD 168 in 1983, DD 169 and 170 in 1987. With Harpoon, instead of adding the simple individual launch tubes as most other navies (including the US Navy) have done, the JMSDF decided to utilise the magazine and Mk 13 Mod 4 single-arm launcher already installed for Standard missiles. This means, of course, that the number of Standards is reduced by the number of Harpoons.

DEPLOYMENT

The normal deployment of these three ships is:
2nd Escort Flotilla (Sasebo): *Sawakaze* (DDG 170)
4th Escort Flotilla (Kure): *Tachikaze* (DDG 168); *Asakaze* (DDG 169)

Tachikaze (H & L van Ginderen Collection)

HATAKAZE



Hatakaze (Ian Sturton)
1 *Flight deck* **2** *127 mm (5 in)/54 Mk 42 single mounting* **3** *Mk 15 Vulcan Phalanx 20 mm CIWS* **4** *Melco 2-21 fire-control radar (127 mm guns)* **5** *Melco OPS-11C radar (air search)* **6** *Mk 32 324 mm triple torpedo launcher* **7** *Harpoon SSM launcher-containers (eight)* **8** *Satcom* **9** *NEC ORN-6 TACAN* **10** *JRC OPS-28B surface search* **11** *Hughes SPS-52C radar (air search)* **12** *Raytheon SPG-51C fire control (Standard)* **13** *Type 2-12 radar* **14** *Mk 112 ASROC eight-cell launcher* **15** *Mk 13 Mod 4 launcher for Standard SM-1MR*

GENERAL SPECIFICATIONS

Operator: Japan

Class: HATAKAZE

Built: 2
Active: 2

Displacement:
standard: 4,600 t (4,650 t, DD 172)
full load: 5,500 t

Dimensions
Length: 150 m (492 ft)
Beam: 16.4 m (53.8 ft)

Draught: 4.8 m (15.7 ft)

Speed: 30 kts

Complement: 260

SHIPS

HATAKAZE (DDG 171)

Builder	Mitsubishi, Nagasaki, Japan
Laid down	20 May 1983
Launched	9 Nov 1984
Commissioned	27 Mar 1986

SHIMAKAZE (DDG 172)

Builder	Mitsubishi, Nagasaki, Japan
Laid down	30 Jan 1985
Launched	30 Jan 1987
Commissioned	23 Mar 1988

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas UGM-84B Harpoon

Eight Harpoon anti-ship missile canisters are mounted immediately abaft the stack; there are two groups of four launchers each, with each group pointing across the ship to the opposite beam. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options. One of these is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

SURFACE-TO-AIR MISSILES (SAM)

Standard Missile-1 Medium Range (SM-1MR)

Main air defence armament is the SM-1MR which is launched from the Mk 13 Mod 3/4 launcher on the foredeck. The below deck magazine holds 40 missiles. When the target is detected the data is evaluated by the ship's command system and the target is designated for the missile fire-control system, which then tracks and illuminates it. Each SPG-51C tracker/illuminator radar usually controls one missile. Once the missile is launched, the tracker's main illumination beam holds the target while the rear reference illuminator beam provides guidance data through the missile's rear reference antenna. This guides the missile until the onboard seeker detects the CW reflected energy from the main illuminator beam. The onboard guidance system then brings the missile to an interception course. SM-1MR Block IV missiles have a Naval Weapon Center Mk 51 expanding rod warhead, while Block V missiles have a Naval Weapon Center Mk 90 blast fragmentation warhead.

Specifications
Length: 4.48 m (14.7 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.06 m (3.48 ft)
Weight: 642.3 kg (1,416 lb)
Speed: Mach 2
Range: 20.5 n miles (38 km)
Altitude: 19,800 m (65,000 ft)

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA.
Raytheon, Missile Systems Division, Bedford, Maryland, USA.

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

There is a single Mk 112 launcher on the foredeck, with a magazine immediately behind it. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 460 m (1,500 ft).

When a submarine target is detected it is tracked and the attack console's fire-control computer predicts the

target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (197 and 1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (1,968 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and as they separate the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications
ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor
Honeywell Training and Control Systems, West Covina, California, USA.

TUBES

324 mm Type 68 (triple) tubes
Two triple 324 mm Type 68 torpedo tubes are sited amidships, one set on either beam. This is a US Mk 32 installation, manufactured under licence in Japan.

Specifications
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

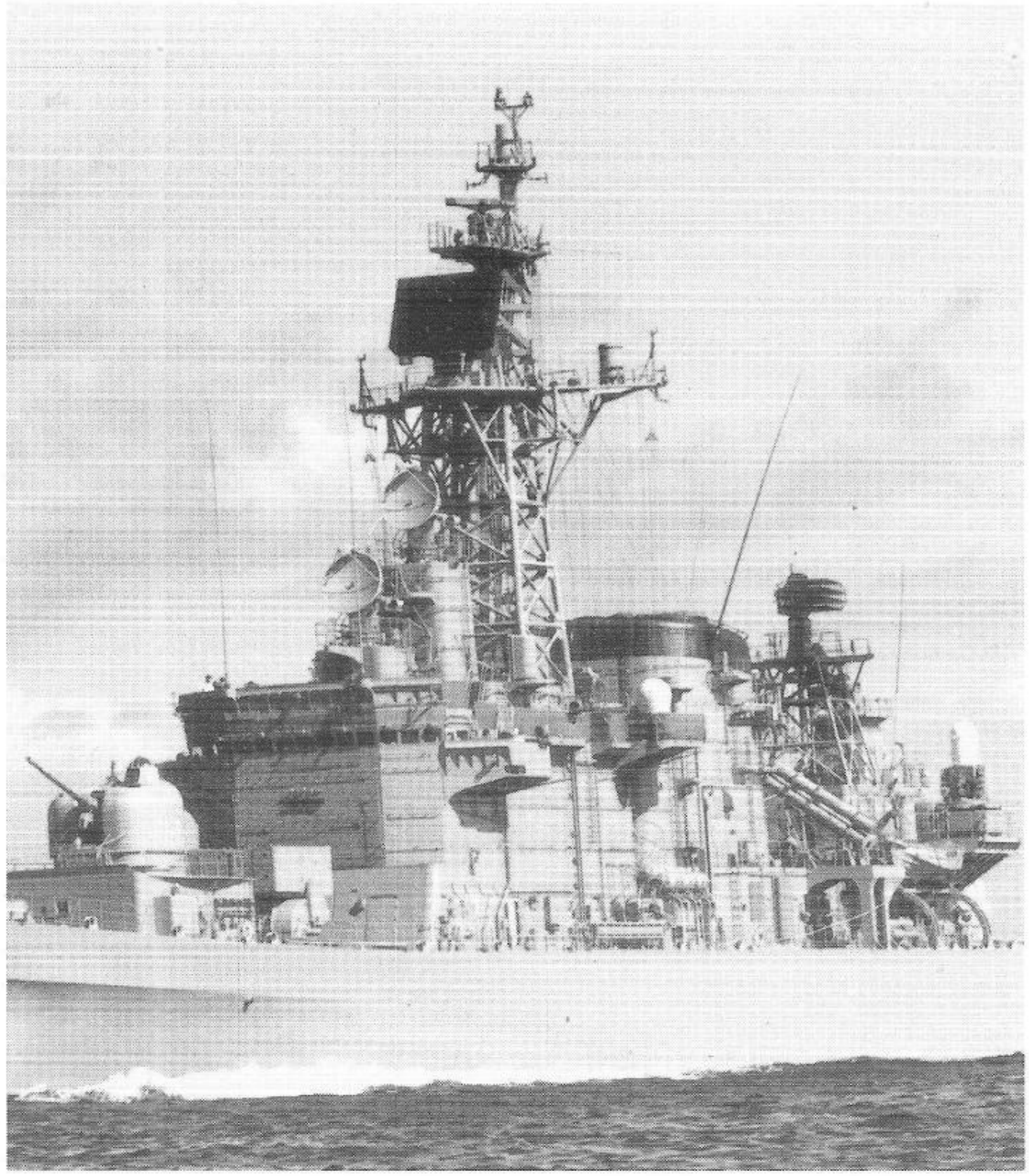
Alliant Techsystems Mk 46 Mod 5 (Neartip) 324 mm torpedoes

Specifications
Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: Liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

Manufacturer/Contractor
Alliant Techsystems, Mukilteo, Washington, USA.

GUNS

United Defense Mk 42 Single 127 mm (5 in)/54 gun mounting
There are two Mk 42 mountings, each housing a single Mk 18 127 mm/54 gun; the forward mounting is located in 'A' position on the foredeck and the after mounting in 'Y' position on the quarterdeck. The Mk 18 gun has a two-piece barrel with replaceable liner and a service life of some 2,000 rounds. A bayonet-type joint attaches the gun to the housing which includes a vertical sliding breech block and the entire gun assembly is supported on rollers in the slide. A separate rammer is mounted on the slide.



Hatakaze *(DDG 171). The foremast is covered with sensors. At the head is ORN-6 TACAN and below it (on the platform) OPS-28B surface search radar. The large rectangular array is SPS-52C air search, while the cylindrical radome on the yardarm is probably a jammer. Forward of the mast are two SPG-51C for control of the Standard SM-1MR missiles. Another ECM device is at the foot of the forward leg of the mast, with a Satcom dome immediately in front of the very large stack. At the head of the mainmast is the OPS-11C air search antenna* (Hachiro Nakai)

The Mk 42 mounting was introduced in 1953 and was produced in Japan under licence. The upper part of the mounting is fully power driven and is enclosed in an armoured shield. The Mk 42 mounting requires a crew of 12: four men within the shield and eight in the magazine and ammunition handling system.

Ammunition is loaded by a dual system with projectiles supplied automatically to the slide alternately from the right and left. The loading system consists of two manually loaded drums, one with 20 projectiles and the other with 20 charges, which rotate to bring the projectile and cartridge together. Complete rounds are lifted from the lower hoist to the upper hoist and from there to the cradles which move them to the tray from where they are rammed into the breech.

Magazine capacity is 550 rounds and ammunition includes the Mk 41 AAC/HC, Mk 42 common, and Mk 48 illumination rounds, all of which weigh 31.75 kg. All rounds have point detonating, proximity or mechanical time fuzes.

Specifications
Gun, 127 mm/54 Mk 18
Calibre: 127 mm
Length of barrel: 54 calibres

Hatakaze *(DDG 171) name ship of class of two large guided-weapon destroyers. On the foredeck is a Mk 13 Mod 4 twin-arm launcher, a 127 mm (5 in)/54 Mk 42 automatic gun and a Mk 112 ASROC launcher, a heavy concentration of anti-air, anti-surface and anti-submarine weaponry* (H & L van Ginderen Collection)

This stern view of Shimakaze *(DDG 172) shows the remainder of the armament. Just behind the stack are eight Harpoon launchers, with two Mk 15 Phalanx CIWS either side of after superstructure and the second 127 mm (5 in) gun on the quarterdeck. These ships have a flight deck for helicopters but do not have a hangar* (H & L van Ginderen Collection)

Muzzle velocity:
new barrel: 807 m/s (2,648 ft/s)
mid-life: 792 m/s (2,600 ft/s)
Max range: 12 n miles (22 km)
Max altitude: 14,400 m (47,000 ft)
Ammunition: 31.75 kg (70 lb)

Mounting, Mk 42
Traverse: 360° at 40°/s
Elevation: −15 to +85° at 25°/s
Rate of fire: 20-40 rds/min

Manufacturer/Contractor
United Defense Armaments Systems Division, Minneapolis, Minnesota, USA.

Hughes Mk 15 CIWS Phalanx
There are two Hughes Mk 15 Phalanx close in weapons systems (CIWS) situated either side of the after deckhouse. The mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications
Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor
Hughes Missile Systems, Tucson, Arizona, USA (system).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

Mitsubishi NOLQ-1-3
NOLQ-1-3 is the standard JMSDF intercept/jammer and is reported to be very similar to the Raytheon AN/SLQ-32(V)3 (Sidekick).

Manufacturer/Contractor
Mitsubishi Electric Corporation (MELCO), Tokyo, Japan.

Fujitsu OLR-9B
OLR-9B is a manually operated radar-warning and intercept system, similar to the US Navy's AN/WLR-11.

Manufacturer/Contractor
Fujitsu, Tokyo, Japan.

Prairie Masker
The ships are fitted with the US Navy's Prairie Masker 'blade-rate suppression' system.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher
There are two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications
Launcher
Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Rounds
Diameter: 130 mm (5.1 in)
Length, weight:
Mk 182: 1,209 mm; 22.7 kg
Super Chaffstar: 1,209 mm; 20.9 kg
Super Gemini: 451 mm; 5.5 kg
Super Hiram III: 1,220 mm; 13.6 kg
Super Hiram IV: 467 mm; 3.8 kg
Super Loroc: 734 mm; 13.2 kg

Manufacturers/Contractors
Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

OYQ-4 Mod 1 action data automation
OYQ-4 Mod 1 is the air defence command system found only in the 'Hatakaze' class. OYQ-4 takes inputs from onboard sensors and from external sources via datalinks such as Link 11 and Link 14, and communicates directly with the Mk 74 control system which handles the Standard SM-1MR missiles. Sonar data is handled separately.

COMMUNICATIONS AND DATALINKS

In addition to normal communications systems, the 'Hatakaze' class is fitted with:
Link 11
Link 14
Satcom.

WEAPONS CONTROL

Mitsubishi GFCS Model 2-21C
There is one GFCS Model 2-21C (also known as the Type 79) system to control the fire of the two 127 mm (5 in) guns. The radar operates in the I/J band.

Manufacturer/Contractor
Mitsubishi Electric Corporation (MELCO), Tokyo, Japan.

Raytheon Mk 74 Mod 13 for Standard
The Mk 74 missile fire-control system acquires, tracks and illuminates targets which it has been assigned by the OYQ-4 system. Mk 74 is not involved in the launch sequence, but takes over after missile launch, when it monitors the missile and controls it until interception of the target; it then carries out a post-launch evaluation.

All Mk 74 systems consist of an AN/SPG-51C G/H-I/J-band radar, a Mk 73 director and associated consoles, but the Mod 13 does not use a computer, using a CV 3432 radar data processor instead. The SPG-51C has two independent channels each with a G/H-band tracking radar and an I/J-band illumination transmitter. This radar has longer detection and acquisition ranges than its predecessor, and automatic target scheduling, which require fewer operator decisions. The Mk 73 director is a rotating electronic structure which includes the transmitter group, the control power supply for CW injection, the power supply for the pulse Doppler system, and a radar data converter. It can traverse up to 360° while elevation limits are −30 to +83°.

Manufacturer/Contractor
Raytheon, Missile Systems Division, Bedford, Maryland, USA.

RADARS

Hughes SPS 52C, 3D

Specifications
Role: long-range air search
Frequency: E/F band
Range: 240 n miles (440 km)
Beam: 1.1 × 2.25°
Peak power: 1,000 kW
Gain: 39.5 dB
Pulsewidth: 2.5/4.6/10 µs
PRF: 1,850/925 pps
Scan rate: 15/6 rpm

Mitsubishi OPS 11C
OPS-11C is a Japanese-designed, long-range, air-search radar, operating in the B/C/D bands. OPS-11B operates at 300 MHz (B band).

JRC OPS-28
OPS-28 is a surface search and short-range air search radar, operating in the G and H bands. OPS-28 replaced OPS-17 and OPS-18

Raytheon SPG 51C
Two Raytheon SPG 51C, fire control for Standard SM-1MR.

	Track	Illuminate
Frequency	F band	G/H band
Beam	1.6°	0.9°
Peak power	81 kW	5 kW
Gain	39.5 dB	45 dB
Pulsewidth	2.1-3.2µs	

Manufacturer/Contractor
Raytheon, Missile Systems Division, Bedford, Maryland, USA.

Mitsubishi Model 2-21
Two Mitsubishi Electric 2-21 for gunfire control. They operate in the I/J band.

Manufacturer/Contractor
Mitsubishi Electric Corporation (MELCO), Tokyo, Japan.

TACAN
NEC ORN-6.

SONARS

NEC OQS-4
OQS-4 is a Japanese-designed, improved version of the OQS-3, which was a licence-produced version of the US Navy's SQS-23. OQS-4A is a bow-mounted, active search and attack sonar, operating at medium frequencies.

Manufacturer/Contractor
NEC, Tokyo, Japan.

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: There is a large flight deck, but no RAST, hangar or any other aviation facilities. The flight deck can accommodate a Mitsubishi HSS-2B Sea King or SH-60J Seahawk

PROPULSION

Specificatons
System: Combined gas or gas (COGAG)
Main machinery: 2 Rolls-Royce Olympus TM3B gas-turbines; 36.8 MW (49,400 hp) sustained; 2 Rolls-Royce Spey SM1A gas-turbines; 19.9 MW (26,650 hp) sustained
Shafts: 2
Propellers: KaMeWa cp props

FURTHER INFORMATION

PROGRAMME

DD 171 was provided for in the 1981 programme, followed by DD 172 in the 1983 programme, but an attempt to fund a third of class in the 1985 programme was turned down. The programme therefore ended with completion of the second ship in 1988.

DESIGN

The 'Hatakaze' class was developed from the 'Tachikaze' class, but incorporated a variety of improvements, of which the most significant was the change from steam-turbine to gas-turbine propulsion. The four Rolls-Royce gas-turbines (two Olympus, two Spey) resulted in the engine uptakes being grouped together into one, very large stack, which altered the external appearance of the ships dramatically.

Standard SM-1MR launcher and magazine have been moved from the quarterdeck to the foredeck, which now accommodates this launcher, a 127 mm gun and the Mk 112 ASROC launcher, together with their respective, below decks magazines. As a result the foredeck in the 'Hatakaze' class is considerably longer than that in the 'Tachikaze' class. There is also a substantial bulwark, making the Hatakazes the only Japanese destroyers to have such a feature.

Other changes include the addition of eight Harpoon launchers, which are located immediately abaft the stack and two Phalanx CIWS on platform decks either side of the after deckhouse.

Shimakaze *(DDG 172)* (H & L van Ginderen Collection)

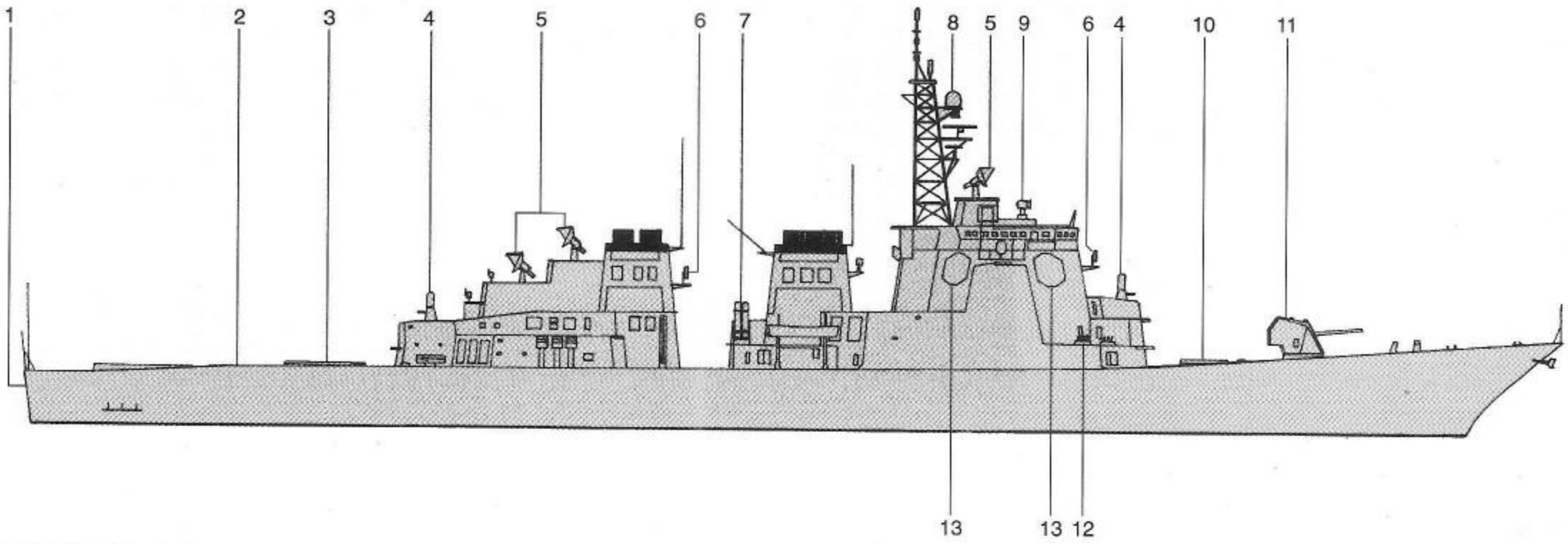
The sensor fit is comprehensive, but the SPG-51C fire-control directors for the Standard SM-1MR have been moved from their position aft in the 'Tachikaze' class to above the bridge in the 'Hatakaze' class.

The two 'Hatakaze' class ships have a flight deck, but no other facilities for helicopters.

DEPLOYMENT

Hatakaze (DDG 171) is part of 1st Escort Flotilla (Yokosuka), while *Shimakaze* (DDG 172) is part of 3rd Escort Flotilla (Maizuru).

KONGO



Kongo (Ian Sturton)
1 *Oki OQR-2 TACTASS towed array* **2** *Flight deck* **3** *Lockheed Martin Mk 41 VLS (61 missiles)* **4** *Mk 15 Vulcan Phalanx 20 mm CIWS* **5** *SPG-2 fire control (Standard SAM)* **6** *Satcom* **7** *Harpoon SSM launchers (total eight)* **8** *JRC OPS-28C/D radar (surface search)* **9** *GFCS-2-21 fire control (127 mm (5 in) gun* **10** *Lockheed Martin Mk 41 VLS (29 missiles)* **11** *OTOBREDA 127 mm (5 in) Compatto automatic gun* **12** *Mk 36 SRBOC decoy launcher (total four)* **13** *AN/SPY-1D Aegis planar arrays (total four)*

GENERAL SPECIFICATIONS

Operator: Japan

Class: KONGO

Active: 3
Building: 1

Displacement:
standard: 7,250 t
full load: 9,485 t

Dimensions
Length: 161 m (528.2 ft)
Beam: 21 m (68.9 ft)

Draught: 6.2 m (20.3 ft); 10 m (32.7 ft) (sonar)

Speed: 30 kts
Range: 4,500 at 20 kts

Complement: 300

SHIPS

KONGO (DD 173)
Builder Mitsubishi, Nagasaki, Japan
Laid down 8 May 1990
Launched 26 Sep 1991
Commissioned 25 Mar 1993

KIRISHIMA (DD 174)
Builder Mitsubishi, Nagasaki, Japan
Laid down 7 Apr 1992
Launched 19 Aug 1993
Commissioned 16 Mar 1995

MYOKO (DD 175)
Builder Mitsubishi, Nagasaki, Japan
Laid down 8 Apr 1993
Launched 5 Oct 1994
Commissioned 14 Mar 1996

(DD 176)
Builder Ishikawajima Harima, Tokyo, Japan
Laid down 29 May 1995
Launched Aug 1996
Commissioned Mar 1998

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas UGM-84B Harpoon

Eight Harpoon anti-ship missile canisters are mounted immediately abaft the forward stack; there are two groups of four launchers each, with each group pointing across the ship to the opposite beam. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options. One of these is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

Hughes Standard Missile 2 (SM-2MR)

The 'Kongo' class is the first in the JMSDF to be armed with standard SM-2MR, other AAW ships having the earlier SM-1MR version. This new missile can be used for both surface-to-air and surface-to-surface engagements and is 24 cm (9.45 in) longer than the previous version. The guidance assembly incorporates fast Fourier techniques in the signal processor and it possesses a passive home-on-jam capability. The propulsion section uses the Thiokol Mk 104 dual thrust rocket motor with ARC acting as second source. This is a more powerful motor than its predecessor and it provides substantial improvements in speed and manoeuvrability as well as a 60 per cent increase in range.

The SM-2 missile's course is controlled from the ship by means of an RF link until the target comes within the missile seeker's field of view. This system allows the use of the ship's search radar to provide missile launch data and by shaping the missile flight path into an energy-efficient trajectory the effective range of the system is doubled.

In the US Navy system an AN/SYR-1 communications tracking set with phased array antenna is included in the ship fit to assist the monitoring of the missile's flight. It is assumed that the Kongos have a similar arrangement to receive data downlinked from the missile and transmit it to the WDS. The SYR-1 has two receivers and can receive data from many missiles by using time-sharing techniques.

Specifications

(SM-2MR)
Length: 4.72 m (15.49 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.06 m (3.47 ft)

The 'Kongo' class carries 98 missiles: 29 in the forward vertical launcher; 61 in the aft vertical launcher; and eight Harpoons (Hachiro Nakai)

Weight: 706.7 kg (1,558 lb)
Speed: Mach 2.5
Range: 37.75 n miles (70 km)
Altitude: 19,800 m (65,000 ft)
Guidance: semi-active radar homing

Manufacturer/Contractor
Hughes Missile Systems, Tucson , Arizona, USA.
Raytheon Missile Systems Division, Bedford, Maryland, USA.

ANTI-SUBMARINE MISSILE

Honeywell RUR-5A ASROC
ASROC missiles share the vertical launchers with the Standard SM-2MR missiles, there being capacity for a total of 90 missiles. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 460 m (1,500 ft).

When a submarine target is detected it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (197 and 1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (1,968 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and as they separate the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications
ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75) in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103.

Manufacturer/Contractor
Honeywell Training and Control Systems, West Covina, California, USA.

TUBES

324 mm Type 68 (triple) torpedo launchers
Two Type 68 324 mm torpedo launchers, each consisting of three HOS 301 tubes, are sited amidships, one set on either beam. This is a US Mk 32 installation, manufactured under licence in Japan.

Specifications
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

Alliant Techsystems Mk 46 Mod 5 torpedo

Specifications
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor
Alliant Techsystems, Mukilteo, Washington, USA.

GUNS

OTOBREDA 127 mm/54 Compatto
The OTOBREDA 127 mm/54 Compatto has been selected for use in the 'Kongo' class, the first time this gun has been used in the MSDF. This weapon is designed to provide naval gunfire support, to engage surface targets and to engage air targets, including anti-ship missiles and fixed-wing aircraft which do not have stand-off weapons.

The turret is unmanned and is enclosed by a fibreglass shield. Much of the turret and the lower part of the mounting are made of aluminium alloy. The below-deck element of the mounting consists of three drums each containing 22 rounds, which are stocked automatically from two chain-driven lower hoists which lead to the magazines and are loaded manually. The gun captain uses his control to select which drums are to be replenished and with what ammunition. Japanese versions are reported to have an improved console with modern electronics including BITE facilities. The weapon is compatible with all US 5 in L/54 ammunition.

Specifications
Gun
Calibre: 127 mm
Length of barrel: 54 calibres
Muzzle velocity: 808 m/s (2,625 ft/s)
Range:
anti-air: 13,600 m (45,000 ft)
anti-surface: 8.6 n miles (16 km) surface/surface
Rate of fire: 45 rds/min
Weight of shell: 32 kg (70 lb)

Mounting
Compatto
Training: 330° at 40°.s
Elevation: −15 to +83° at 30°/s
Mounting weight: 37.5 t (empty)
Crew: 5

Manufacturer/Contractor
OTOBREDA, La Spezia, Italy.

Hughes Mk 15 CIWS Phalanx
There are two Hughes Mk 15 Phalanx close in weapons systems (CIWS); one is located on a platform immediately before the bridge, the other on a platform aft. The mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications
Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor
Hughes Missile Systems, Tucson, Arizona, USA (system).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

NEC NOLQ-2
NOLQ-2 is a new ECM intercept and jamming equipment.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher
There are two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications
Launcher
Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Kirishima *(DD 174) showing one of the four SPY-1D planar arrays* (H & L van Ginderen Collection)

Rounds
Diameter: 130 mm (5.1 in)
Length, weight:
Mk 182: 1,209 mm; 22.7 kg
Super Chaffstar: 1,209 mm; 20.9 kg
Super Gemini: 451 mm; 5.5 kg
Super Hiram III: 1,220 mm; 13.6 kg
Super Hiram IV: 467 mm; 3.8 kg
Super Loroc: 734 mm; 13.2 kg

Manufacturers/Contractors
Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

Aerojet AN/SLQ-25 Nixie noisemaker
One AN/SLQ-25 Nixie (Phase 1), a solid-state, modular design electro-acoustic countermeasures decoy system is used to protect the ship from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter to generate and amplify the signals, a power-operated double-drum winch for streaming/ recovering the towed bodies, and a coaxial switching unit. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 488 m (1,600 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 95 cm long (3.10 ft), 15.24 cm (6 in) in diameter and weigh 18 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body is deployed at a time.

Manufacturer/Contractor
Aerojet ElectroSystems, Sacramento, California, USA.

COMMAND AND CONTROL SYSTEMS

WEAPONS SYSTEMS

Lockheed Martin Aegis Weapon System Mk 7/GWS Mk 34/FCS Mk 99
The 'Kongo' class destroyers are equipped with the Aegis command and weapon control system, which integrates the management of a task group's combat assets for air, surface and underwater operations, although the main emphasis is on air operations. It is designed to react quickly and with sufficient firepower to destroy fast, intelligent targets in severe ECCM and environmental conditions. The system is based on a federated architecture consisting of four subsystems: the SPY-1D multifunction radar; Command and Decision System (CDS); Aegis Display System (ADS); and the Weapons Control System (WCS). There are currently five basic configurations (known as 'baselines') and seven versions (designated 'modifications' (Mods)), but it is not known which the JMSDF are using.

In the Japanese version of the system there is only one other radar: the JRC OPS 28C/D, a G/H band set used for surface surveillance, including detecting and tracking low-flying aircraft, as well as detecting small surface targets such as submarine periscopes. small surface targets, and to track low-flying aircraft and to detect submarine periscopes.

The Command and Decision System (CDS) Mk 1 provides overall operational direction and co-ordination, receiving data not only from onboard sensors, but also from offboard sensors via Link 11 and Link 14. In addition to inputs from radar and sonar sensors CDS also receives inputs from the AN/SLQ-32 electronic warfare suite. The system is used to help assess threats and will assign engagement instructions to the WCS.

The Aegis Display System (ADS) enables the ship's commander, his tactical action officer and the task group commander (if embarked) to assess the operational situation and to issue orders both to onboard and offboard weapon systems and units.

The Weapons Control System (WCS) conducts the engagement of targets in the air, on the surface and underwater, although priority is given to the anti-air battle. The system interfaces with sensors of various onboard systems and offboard systems with direct links to the SH-60J ASW helicopter. The system receives engagement instructions through the CDS and selects the appropriate weapons system and weapon. It schedules targets, issues firing orders and controls surface-to-air missiles launched by the Mk 99 fire-control system until they are close to the interception point.

The WCS interfaces with several fire-control systems and the Phalanx CIWS. The fire-control systems include the Type 2-21 (127 mm (5 in) gun), the anti-submarine system and the AN/SWG-1A (Harpoon), the missile launching system, and the Aegis integral surface-to-air missile fire-control system, the Mk 99. The Mk 99 fire-control system generates director and launcher commands for the slaved SPG-62 illuminators which are also used to provide target illumination for missiles from other ships, selects the missile engagement mode then acquires and tracks the target using uplink mid-course command guidance through the SPY-1D, which generates continuous targeting data, to guide the missile close to the target which is then illuminated by the SPG-62s for the terminal phase.

The Aegis system has four operating modes; automatic, automatic special, semi-automatic and casualty. The automatic special mode ensures that targets which meet predetermined threat criteria will be automatically engaged unless the order is overridden manually. The other modes are self-explanatory but in all of them the firing is initiated manually. The command system monitors the whole Aegis system through the ORTS which monitors critical operating points, detects faults and provides maintenance data for the crew.

Design of the Kongo *(DDG 173) was closely based on that of the US Navy's* Arleigh Burke *but it is somewhat larger. The apparent lack of antennas and sensors belies a most sophisticated command and control system* (Hachiro Nakai)

The WCS accepts weapon assignment commands and special threat criteria from the command system, together with tracking data from the multifunction radar. The data is processed and also displayed on the display system to determine the possibility of engaging the target. Traverse and elevation commands are then transmitted to the launcher and prelaunch commands are transmitted to the missile, together with target illumination data for the Mk 99 fire-control system. Trail intercepts are computed and time-to-fire predicted, the data being transmitted to the command system. Once the missile is fired the weapons control system can request the command system to carry out mid-course guidance through the multifunction radar.

Manufacturers/Contractors

Lockheed Martin, Ocean and Radar systems (prime).
Unisys (computers).
Computer Sciences Corporation (software).
Hughes Missile Systems (displays).
Raytheon (Mk 99 fire-control system).

COMMUNICATIONS AND DATALINKS

Datalinks: Link 11; Link 14; Link 16 in due course
Satcom: OE-82C.
Tacan: UPX-29
IFF.

WEAPONS CONTROL

Loral Mk 116 Mod 7 anti-submarine fire-control system

The Mk 116 Mod 7 Underwater Fire-Control System provides tactical data processing, contact management, target engagement processing and weapon fire control and consists of two elements: the Computer Processing Subsystem (CPS) and the Weapon Control and Setting Subsystem (WCSS). Data are also received from external sensors and distributed around the system by an integral switchboard or data converter.

The CPS provides displays of tactical data, computes and stores track data, calculates weapon control firing solutions for selected targets and generates weapon recommendations and launcher orders. Mod 7 uses NTDS hardware with two AN/UYK-43B computers, each with two Central Processing Units (CPU) with a memory of 2.56 million words and an optimum processing power of 3.002 million operations/s.

The prime sensor in this version is the bow-mounted, low frequency OQS-102 (a Japanese version of the US Navy's AN/SQS-53 active-passive sonar).

Manufacturer/Contractor

Loral Librascope.

RADARS

Lockheed Martin AN/SPY-1D

The SPY-1D has the four characteristic planar array which are installed around the bridge, angled upwards at approximately 45° to enable them to maintain accurate co-ordination even when the ship is rolling at angles of ±30° or pitching at ±15°.

The SPY-1D has much lighter and smaller antennas than earlier models, with a signal processor to control the high-power, ultra-precision, garnet, phase-shifters which integrate microwave and electronic hardware. There are 4,100 phase-shifters in each antenna steering the beam to cover the sectors and designated targets, although some phase-shifters are also used to eliminate sidelobes. The SPY-1D makes considerable use of VLSI technology.

Specifications

(SPY-1D)
Role: 3-D air search
Band: E/F (2-4 GHz)
Beam: 1.7 × 1.7°
Peak power: 4-6 MW
Gain: 42 dB
Pulsewidth: 51/25.4/12.7/6.4 µs
PRF: Variable
Scan rate: 12 scans/min

Manufacturer/Contractor

Lockheed Martin.

JRC OPS 28C/D

OPS-28 is a surface search and short-range air search radar, operating in the G and H bands.

OPS 20

OPS-20 is an I-band navigational radar.

SPG-62

SPG-62 is a component of the Aegis system and is used to illuminate the target during the final seconds of the Standard missile's flight, thus providing terminal guidance. The Kongos mount three SPG-62s, one on the bridge roof and two on top of the after superstructure. SPG-62 operates in the H/I bands, and has an average output power of 10 kW.

SONARS

OQS-102/OQR-2

The full US Navy AN/SQQ-89 does not appear to have been exported, but a similar system has been developed for the Japanese 'Kongo' class destroyers. No details of the Japanese system have been revealed but its architecture and performance are assumed to be very close to those of the AN/SQQ-89.

AN/SQQ-89(V) is a surface ship anti-submarine warfare combat system designed to detect, locate, track and engage submarine targets. It transmits and/or receives acoustic signals using a variety of sensors to provide target classification as well as performing TMA and controlling the setting of 'own ship' ASW weapons. In addition it provides multisensor track correlation, track management control and forwards track data to ship's Combat Direction System (CDS) or Command and Decision System (C&DS).

The system is an integrated combat system which consists of two or three sonar sensors which interface either with the Mk 116 fire-control system, providing maximum operational effectiveness for the minimum operating manpower.

If the installation is analogous to the US Navy's system, then the sensors integrated in the Kongos' system will be the OQS-102 bow-mounted sonar, the OQR-2 (SQR-19(V)) Tactical Towed Array Sonar (TACTAS), and the AN/SQQ-28 SH-60J helicopter's Sonar Signal Processing System (SSPS).

The fire-control subsystem is the Mk 116 (see above).

NEC OQS-4A (II)

OQS-4A is a Japanese-designed, improved version of the OQS-3, which was a licence-produced version of the US Navy's SQS-23. OQS-4A is a bow-mounted, active search and attack sonar, operating at low frequencies.

Oki OQR-2

The OQR-2 (AN/SQR-19(V)) is a passive, long-range, omnidirectional towed array, used to detect and classify submarine targets. In its original US Navy form (and it is assumed that the JMSDF system is identical) the towed array group consists of an 82 mm diameter array towed on a 1 n mile (1.7 km) cable to depths as low as 365 m.

AN/SQQ-28

The AN/SQQ-28 SSPS is the shipboard processor for the SH-60s weapon system and processes raw data relayed to the ship via the AN/SQR-4 duplex digital link and received by the AN/ARR-75.

Manufacturer/Contractor

Lockheed Martin Ocean and Radar Systems (prime).

AVIATION

AVIATION FACILITIES

There is no hangar, but there is a landing platform and refuelling facilities for an SH-60J Seahawk.

PROPULSION

Specifications
System: Combined gas and gas (COGAG)
Main machinery: 4 General Electric LM-2500 gas-turbines; 76.21 MW (102,160 hp) sustained

Shafts: 2
Propellers: cp

FURTHER INFORMATION

PROGRAMME

These are among the most sophisticated and powerful surface warships in any navy and, as well as air defence of the Fleet, they are required to contribute to the air defences of mainland Japan. They were proposed in the FY 1987 programme and the first was authorised in FY 1988 estimates, second in FY 1990, third in FY 1991, fourth in FY 1993. The combination of very high costs and the reluctance of the US Congress to release Aegis technology slowed the programme down, but it is now estimated that the fourth and last ship will be completed by the end of 1998.

DESIGN

This is an enlarged and improved version of the US Navy's 'Arleigh Burke' class, with a lightweight version of the Aegis system. These ships are designated 'destroyers' but their length (161 m; 578 ft) and displacement (9,485 t full load) make them as large as many cruisers, as shown in the table.

The ships' primary mission is anti-air warfare, centred on the AN/SPY-1D system, but unlike the 'Arleigh Burke' class, the *Kongo* has an additional air search radar; OPS-28C.

There are two missile magazines, with a total capacity of 90 missiles; 29 in the forward magazine and 61 aft. The magazines are used not only for Standard SAMs but also for vertical launch ASROC, a missile to which the JMSDF remains committed, despite the apparent lack of enthusiasm for it in the US Navy.

	Country	Displacement (full load)	Length	Beam
Kongo (DDG)	Japan	9,485 t	161 m	21 m
Arleigh Burke (DDG)	USA	9,033 t	153.8 m	20.4 m
Ticonderoga (CG)	USA	9,466 t	172.68 m	16.8 m
Kara (CG)	Russia	9,900 t	173.2 m	18.6 m
Virginia (CGN)	USA	11,300 t	178.3 m	19.2 m

The JMSDF has, for several decades, used Rolls-Royce gas-turbines for propulsion in its major warships, but the 'Kongo' class uses four General Electric GE LM-2500 turbines in a COGAG arrangement.

As with the earlier versions of the 'Arleigh Burke' class (Flights I and II), the 'Kongo' class does not carry a helicopter and there is no aircraft hangar. The area aft of VLS launcher is marked out as a landing platform and a visual landing aid is fitted on the after superstructure. There are no known plans for the JMSDF to build a new version, equivalent to the Arleigh Burke Flight IIA with full helicopter facilities.

The hull is broader and with a greater beam:length ratio than previous Japanese designs and there are large bilge-keels. Among other benefits this arrangement is claimed to give sufficient stability to avoid the need for fin stabilisers.

As in the 'Arleigh Burke' class there is one Phalanx Mk 15 CIWS at either end of the superstructure, but in the Japanese ships the mountings are even higher, giving exceptional fields of fire.

The sonar fit comprises a bow-mounted array (OQS 102) and a towed array (OQR 2), which, in combination, is claimed to be equivalent to the US Navy's SQQ-89.

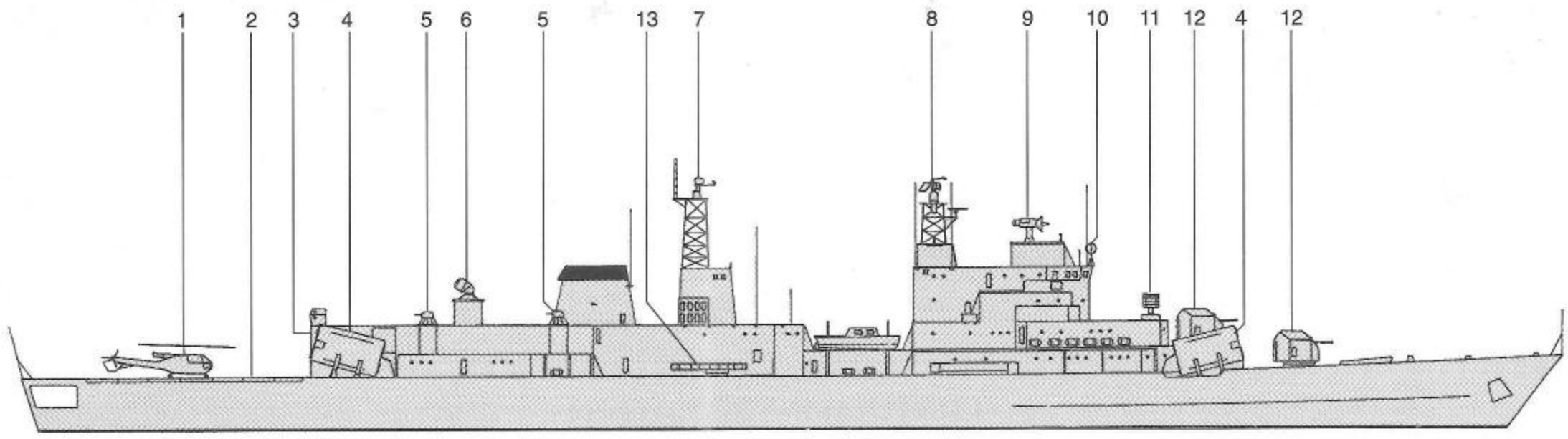
Extensive countermeasures are fitted. There is an elaborate EW suite, SRBOC launchers, IR suppressors are fitted in the stacks and there are Prairie and Masker acoustic suppression systems.

OPERATIONAL

The plan is for one ship to serve with each of the four escort flotillas, the current deployment being:
2nd Escort Flotilla (Sasebo): *Kongo* (DDG 173)
3rd Escort Flotilla (Maizuru): *Myoko* (DDG 175)

Kirishima *(DD 174)* (H & L van Ginderen Collection)

MARASESTI



Marasesti (Ian Sturton)
1 *IAR-316 (licence-built Alouette III) helicopter* **2** *Flight deck* **3** *Hangar* **4** *SS-N-2c twin launcher (two)* **5** *AK-630 30 mm/65 six-barrel Gatling CIWS* **6** *Drum Tilt fire control (for CIWS)* **7** *Strut Curve radar (air search)* **8** *Surface search radar (unknown type)* **9** *Hawk Screech fire director* **10** *Cross Loop communications DF* **11** *RBU-6000 12-barrel trainable ASW mortar (two)* **12** *76 mm (3 in)/60 twin gun mounting* **13** *533 mm (21 in) triple torpedo tubes (two sets of three)*

GENERAL SPECIFICATIONS

Operator: Romania

Class: MARASESTI

Built: 1
Active: 1

Displacement:
standard: 4,500 t
full load: 5,790 t

Dimensions
Length: 144.6 (474.4 ft)
Beam: 14.8 m (48.6 ft)

Draught: 7 m (23 ft)

Speed: 27 kts

Complement: 270 (25 officers)

SHIPS

MARASESTI (111) (ex-Muntenia)
Builder Mangalia Shipyard, Romania
Laid down 1979
Launched 1982
Commissioned 3 Jun 1985

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Raduga P-21 Rubezh (SS-N-2 'Styx') medium-range anti-ship missile

Marasesti's main armament is the P-21 (NATO = SS-N-2c 'Styx'), with four twin launchers, two forward and two aft. Each launcher group consists of two launch bins one above the other, and appear very similar to those fitted in 'Tarantul' class FACs.

The P-21 missile was introduced into service in 1967 and is essentially a P-15 (SS-N-2a) with an added infra-red seeker. This relatively large anti-ship missile is powered by a liquid-fuelled rocket motor, with a solid fuel booster attached, and has been in service since 1967. The Romanian ship uses the Strut Curve radar as the missile fire-control radar.

Once the target is detected the ship must close with the aim of being within the optimum engagement distance, some 15 to 20 n miles (28 to 37 km). Then, when the ballistic solutions have ben obtained, the ship must turn towards the target and, while maintaining a speed of 15 knots or less, hold its course for 20 to 30 seconds before launching the first salvo of two missiles which may be followed, a minute later, by another two.

Upon launch the missile climbs at an angle of 45° to one of five preset altitudes (100, 150, 200, 250 or 350 m), where the onboard radar searches for a target and the receiver is switched on for very short periods to receive signals from a designated range, the range gate being 1 km on either side of the target. The radar locks only after eight returns have been received, at distances of 3.5 to 12 n miles (6.5 to 22 km), whereupon the seeker guidance system switches off the autopilot. A throw-off gyroscope takes the missile on target a few seconds before impact as it becomes too close for radar-generated homing signals.

Russian Navy tacticians calculate that seven to eight missiles are required to destroy a cruiser-size target and four for a destroyer, making salvo firing a major feature of any tactical engagement scenario with SS-N-2c missiles to ensure destruction of the target.

Specifications

(SS-N-2c)
Length: 6.55 m (21.5 ft)
Diameter: 76 cm (30 in)
Wing span: 2.4 m (7.85 ft)
Speed: Mach 0.9
Weight (without booster): 2,500 kg (5,511 lb)
Warhead: 454 kg (1,000 lb) hollow-charge
Fuzes: impact, proximity
Range: 3-46 n miles (5.5-85 km)
Guidance: Autopilot with active radar (supplemented in some with IR)

MS-2 seeker
Frequency: I-band (8-12 GHz) (4 presets)
PRF: 300-500 pps (adjustable)
Altitude control: barometric pressure device

Manufacturer/Contractor

Raduga, Moscow, Russia.

TUBES

There are two triple sets of 533 mm (21 in) torpedo tubes in the waist. They launch Russian Type 53-65 torpedoes.

TORPEODES

RBU-6000

The Romanian ship was originally armed with two RBU-1200 anti-submarine mortars, but these were replaced during the modernisation refit by two 12-tube RBU-6000s. These are mounted side-by-side on the roof of a deckhouse immediately forward of the bridge. The mounting can traverse through 360° and elevation limits are −15° to +60°. Loading is automatic from a below-deck magazine. It is estimated that the rockets weigh 110 kg, with a 25 kg warhead. Pairs of tubes are fired in sequence. The RGB-60 rocket is fitted with an impact-time fuze, which detonates either on hitting a solid object (such as a submarine) or reaches a preset depth. Firing is usually conducted in a full salvo of 12 rockets, but it is also possible to fire single rockets, or four- or eight-rocket salvoes, if the tactical situation requires it. The warhead weighs 31 kg (68 lb).

GUNS

Two AK-726 twin 76 mm (3 in)/59 mountings

The AK-726 is a multirole weapon system designed for air defence, surface engagement and shore bombardment roles and consists of two 76 mm guns mounted in a turret with a 5 mm metal shield. Each gun has its own loading system based upon a continuous supply of ammunition from an intermediate magazine on a below-decks platform under the turret. There ammunition from the main magazine is manually inserted into separate hoists, which carry the rounds into the turret and onto a feeder rail. As the gun recoils the next round is

brought forward for insertion into the breech and as it counter-recoils a new round is brought in position for insertion in the next cycle. The whole mounting can contain 60 rounds of which two are on the feeder rail and four are on the hoists at any one time.

The prime ammunition is the UOFB-62, a fixed round which weighs 12.8 kg. The projectile weighs 4.6 kg and has 400 g of A-IX-2 explosive and a VG-67 point impact fuze.

There is a five-man crew in the turret: the gun captain, two layers and two loaders. There is a further team of four loaders in the below-decks magazine.

AK-726 is associated with Hawk Screech radar which features a circular dish antenna (2.3 m diameter) with central feed on four 'legs'. The transmitter, receiver, turning and stabilisation gears are behind the antenna and the whole director is mounted on a pedestal, approximately 2 m high.

Hawk Screech may also incorporate electro-optic sensors. In addition to radar fire control there is local control through the Prisma optical sighting system, which may be used for engaging targets with speeds of up to 600 m/s (Mach 1.75).

Specifications

Calibre: 76 mm
Length of barrel: 59 calibres
Muzzle velocity: 980 m/s (3,215 ft/s)
Traverse: 360° at 36°/s
Elevation: −7 to +85° at 32°/s
Ammunition (total): 16 kg (35 lb)
Rate of fire: 90 rds/min (whole mounting)
Range:
anti-surface: 8 n miles (15 km)
AA (max): 10,000 m (33,000 ft)
AA (effective): 7,000 m (23,000 ft)

30 mm/65 AK 630 Gatling-type close in weapons system

There are four 30 mm/65 calibre AK-630 Gatling close in weapon systems, which, somewhat surprisingly, are all located aft, two abreast the stack and two on the hangar roof. These have five roles, engaging anti-ship missiles, aircraft, small surface vessels, drifting mines and unprotected targets ashore. The AO-18 weapon is a water-cooled, six-barrelled, Gatling-principle weapon with fixed breech block and revolving barrels. The weapon is believed to operate in a similar manner to that of the Phalanx, firing bursts of up to 400 rounds, but unlike the US weapon AK-630 features a separate radar director (Drum Tilt)

Specifications

Calibre: 30 mm
Length of barrel: 65 calibres
Number of barrels: 6
Muzzle velocity: 890 m/s (2,920 ft/s)
Cooling: Water
Traverse: 360° at 70°/s
Elevation: −12 to +88° at 50°/s
Crew: 1 (off mount)
Range: 4,000 m (13,000 ft) (radar fire control), 5,000 m (16,400 ft) (electro-optic fire control)
Rate of fire: 4,000-5,000 rds/min
Magazine: 2,000 rds
Weight of complete round: 1.224 kg (2.7 lb)
Ammunition types: UOF-84 HE-I weight 384 g; (13.5 oz) UOR-84 HE-T weight 388 g (13.7 oz)
Fuze: MG-32 point impact (both rounds)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Watch Dog radar warning receivers, covering the band 1-12 MHz, are located on the yardarm on the foremast. There is also at least one loop DF antenna.

DECOYS

There are two PK 16 chaff launchers.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS AND DATALINKS

There are numerous rod and wire antennas, and at least one Yagi, but the communications fit appears to be fairly basic.

IFF: High Pole B.

RADARS

Strut Curve

Strut Curve is an F-band air/surface search radar, normally found on smaller Russian warships, such as frigates and corvettes. The antenna is located at the head of the mainmast.

Surface search radar

The surface search radar at the head of the foremast is of an unknown type with a rectangular reflector.

Drum Tilt

Drum Tilt is the H/I band radar used in the fire-control system for the AK-630 CIWS. Normally there is one Drum Tilt to each pair of AK-630s, but it appears that in this ship the single Drum Tilt controls both pairs.

Hawk Screech

Hawk Screech is the I band radar used in the gun fire-control system for the two twin 76 mm mountings.

Spin Trough

Spin trough is normally used as a small ship surface search radar, but it appears that this Romanian ship uses it for navigation. It operates in the I-band.

SONAR

There is a hull-mounted, active search and attack, medium frequency sonar.

Marasesti *in October 1994* (Camil Busquets i Vilanova)

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 27.7 × 14.8 m (91 × 48 ft)
Hangar: The hangar has two doors and accommodates two helicopters

HELICOPTERS

IAR-316B Alouette III

The IAR-316B is an Alouette III, built under licence in Romania from Aerospatiale.

Specifications
Main rotor: 11.02 m (36.15 ft)
Length overall (rotor turning): 12.84 m (42.15 ft)
Fuselage length: 10.17 m (33.7 ft)
Height to rotor head: 3.00 m (9.84 ft)
Weight, empty: 1,143 kg (2,520 lb)
Max take-off weight: 2,200 kg (4,850 lb)
Max speed (never exceed): 113 kts (210 km/h)
Max cruising speed: 100 kts (185 km/h)
Service ceiling: 3,200 m (10,500 ft)
Range with max standard fuel: 267 n miles (495 km)
Engines: One 694 kW (870 shp) Turbomeca Artouste IIIB turboshaft derated to 425 kW (570 shp)
Accommodation: 7 (pilot plus six)

Weapons: In the ASW role the IAR-316B would carry two lightweight torpedoes

PROPULSION

Specifications
System: diesel
Main machinery: 4 diesels; 23.5 MW (32,000 hp(m))
Shafts: 4

FURTHER INFORMATION

PROGRAMME

The Romanian Navy traditionally played a small part in its country's defence activities, so it came as a considerable surprise to foreign observers when evidence accumulated in the late 1970s of a major naval expansion programme. This included five frigates, two minelayers, four minesweepers and two large logistics ships, but the biggest surprise was that a navy and a shipbuilding industry which had previously built nothing larger than fast attack craft, was now constructing a destroyer, described locally as a 'battlecruiser', to a Romanian design.

The result of this endeavour was the Muntenia (later renamed Marasesti), which was launched in 1982 and commissioned in 1987, although it quickly showed signs of instability due to excessive topweight. The political upheavals which culminated in the death of Ceaucescu removed what priority the project had ever had and the ship was laid up for some years. But, again to observers' surprise, it was rebuilt and undertook several voyages, including a short cruise in the Mediterranean.

DESIGN

In general design *Marasesti* is similar to other destroyers of a similar size although it seems unlikely that the Romanian Navy will have had access to the type of sophisticated research and development resources, which are available to Russian and Western navies as a matter of course.

The armament and sensor fit was limited to the Russian equipment then available to the Romanians. It was originally thought that the ship was powered by gas-turbines but it has recently been confirmed that there are four diesel engines, each driving one shaft, although it is unusual for a hull as small as this to have four shafts.

The weapon and sensor fit does not place this design in the forefront of modern naval development. The anti-ship missiles are eight SS-N-2c Styx, and the four guns are elderly 76 mm /60 Russian weapons. ASW weaponry is limited to two RBU-6000 mortars. The electronic equipment is also very limited. There is a large helicopter deck and a two-door hangar which accommodates two Alouette helicopters, whose ASW capability is limited to carrying two lightweight torpedoes.

Altogether it is not a design which would stand much chance of survival in a high-level naval conflict. Nevertheless, despite its shortcomings it must be granted that to design and build such a large and complex warship is a considerable triumph for the Romanian Navy and shipbuilding industry.

MODERNISATION

The ship was deactivated in June 1988 due to a combination of manpower and fuel shortages, and dissatisfaction with the design. However, modernisation work was carried out from 1990 to 1992, with sea trials commencing in mid-1992.

During the modernisation, the topweight problems were addressed by reducing the height of the mast structures and lowering the SS-N-2c missile launchers by one deck. At the same time attempts were made to modernise some of the electronic equipment, although the only change to the armament was to replace the original RBU-1200 with RBU-6000.

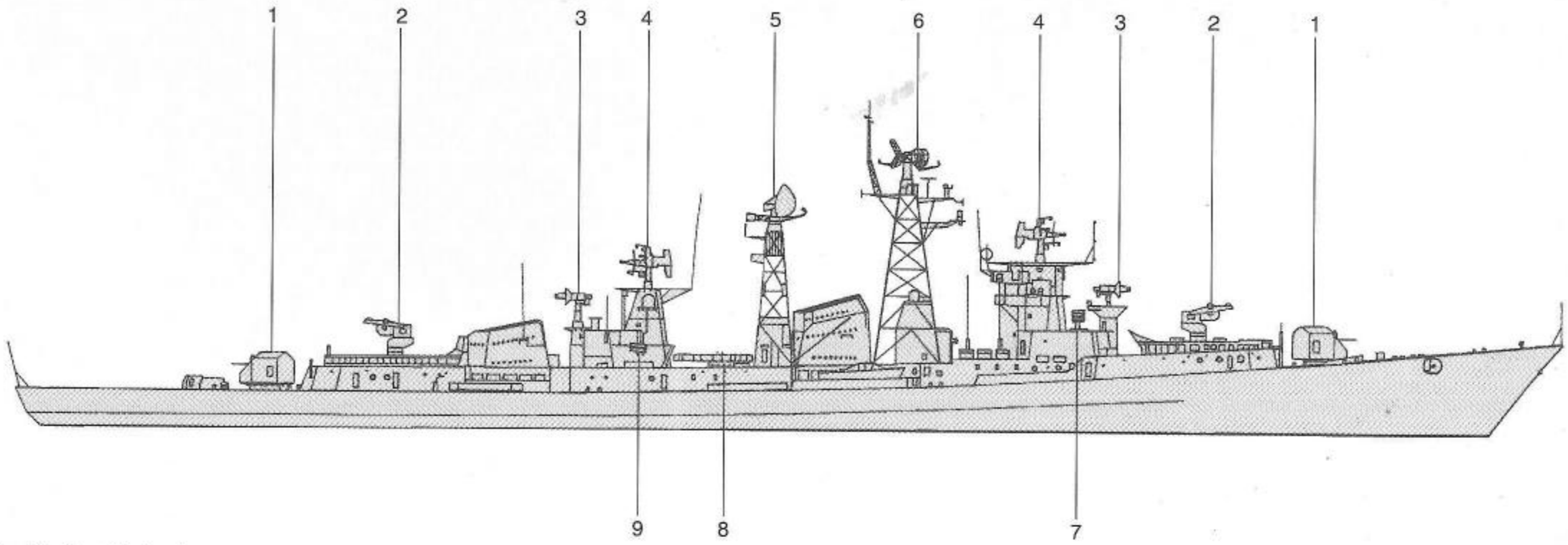
DEPLOYMENT

Following the 1992 sea trials *Marasesti* carried out a major naval exercise in September 1993, which included firing the SS-N-2c missiles. The ship also deployed to the Mediterranean in September 1994 for a short cruise.

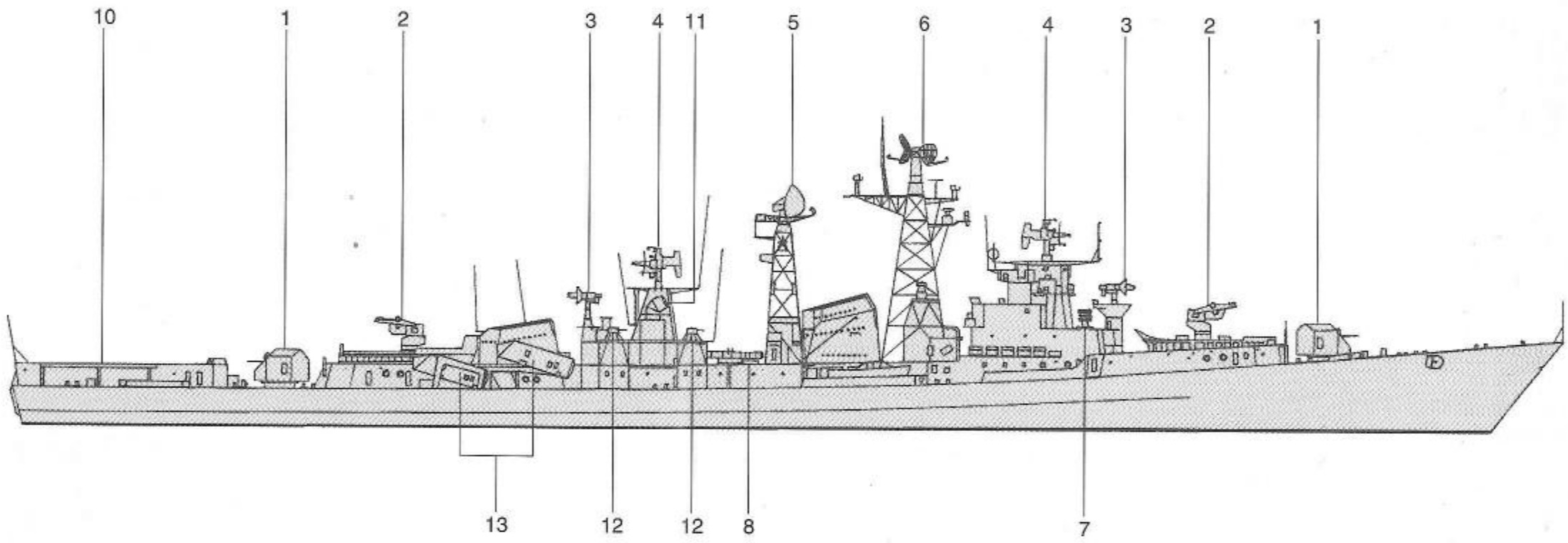
The ship is based at Mangalia and now that it has apparently achieved operational status it can be assumed that it will remain in service for a number of years.

Marasesti *in November 1995. This ship has certainly had problems but is nevertheless a remarkable achievement by the fledgeling Romanian shipbuilding industry* (Giorgio Ghighione)

KASHIN/KASHIN (Mod)



Kashin (Ian Sturton)



Kashin (Mod) (Ian Sturton)

1 *AK-726 76mm (3 in)/60 twin gun mounting* **2** *SA-N-1 Goa twin launcher* **3** *Owl Screech fire control* **4** *Peel Group fire control (SA-N-1)* **5** *Big Net radar (air search)* **6** *Head Net radar (air/surface search)* **7** *RBU-6000 12-barrel ASW mortars (two)* **8** *533 mm (21 in) torpedo tubes (five)* **9** *RBU-1000 six-barrel ASW mortars (two)* **10** *Flight deck* **11** *Bass Tilt fire control (for 30 mm)* **12** *30 mm/65 Gatling CIWS (four)* **13** *SS-N-2c Styx SSM (four launchers)*

GENERAL SPECIFICATIONS

Operator: Russia
Type: Type 61
Designation: *bolshoy protivolodochny korabl* (large anti-submarine ship)

Class: KASHIN

Built: 20
Active: 1

Type: Type 61M

Class: KASHIN MOD

Built: 1
Active: 1

Displacement:
standard: 4,010 t
full load: Kashin 4,750 t; Kashin Mod: 4,974 t

Dimensions
Length:
Kashin: 144 m (472.4 ft)
Kashin Mod: 146.2 m (479.7 ft)
Beam: 15.8 m (51.8 ft)
Draught: 4.7 m (15.4 ft)

Speed:
Kashin: 35 kts
Kashin Mod: 32 kts
Range: 4,000 n miles at 20 kts; 2,600 n miles at 30 kts

Complement: 280 (Kashin — 20 officers) (Kashin Mod — 25 officers)

SHIPS

'Kashin' class

SKORY

Builder	Nikolayev North
Laid down	1964
Launched	1965
Commissioned	30 Sep 1966

'Kashin Mod' Class

SDERZHANNY

Builder	Nikolayev North
Laid down	1969
Launched	1971
Commissioned	4 Nov 1972

SURFACE-TO-SURFACE MISSILES (SSM)

P-21 Rubezh (SS-N-2c 'Styx') medium-range anti-ship missile

Kashin Mod only are armed with the P-21 (NATO = SS-N-2c 'Styx') missile, with two single aft-facing launch bins, one behind the other either side of the after stack. There are no reloads. The P-21 missile was introduced into service in 1967 and is essentially a P-15 (SS-N-2a) with an added infra-red seeker. This relatively large anti-ship missile is powered by a liquid-fuelled rocket motor, with a solid fuel booster attached.

Once the target is detected, the ship must close with the aim of being within the optimum engagement distance, some 15 to 20 n miles (28 to 37 km). Then, since the missile launcher must face the target, the ship must turn away and, while maintaining a speed of 15 knots or less, hold its course for 20-30 seconds before launching the first salvo of two missiles. These may be followed, a minute later, by another two.

Upon launch, the missile climbs at an angle of 45° to one of five preset altitudes (100, 150, 200, 250 or 350 m), where the onboard radar searches for a target and the receiver is switched on for very short periods to receive signals from a designated range, the range gate being 1 km on either side of the target. The radar locks only after eight returns have been received, at distances of 3.5 to 12 n miles (6.5 to 22 km), whereupon the seeker guidance system switches off the autopilot. A throw-off gyroscope takes the missile on target a few seconds before impact as it becomes too close for radar-generated homing signals. Russian Navy tacticians calculate that seven to eight missiles are required to destroy a cruiser-size target and four for a destroyer, making salvo firing a major feature of any tactical engagement scenario with SS-N-2c missiles to ensure destruction of the target.

Specifications

(SS-N-2c)
Length: 6.55 m (21.5 ft)
Diameter: 76 cm (30 in)
Wing span: 2.4 m (7.87 ft)
Speed: Mach 0.9
Weight (without booster): 2,500 kg (5,511 lb)
Warhead: 454 kg (1,000 lb) hollow-charge
Fuzes: Impact, proximity
Range: 3-46 n miles (5.5-85 km)
Guidance: Autopilot with active radar (supplemented in some with IR)

MS-2 seeker
Frequency: I-band (8-12 GHz) (four presets)
PRF: 300-500 pps (adjustable)
Altitude control: Barometric pressure device

Manufacturer/Contractor

Raduga, Moscow, Russia.

M-1 Volnya (NATO = SA-N-1 'Goa') air defence system

Both Kashin and Kashin Mod have two SA-N-1 twin-arm, stabilised, launchers, each with a 16-round magazine. SA-N-1 is a naval version of the Soviet Army's SA-3 and is a command-guided missile with a speed of Mach 3. The missiles are loaded hydraulically with the launch rails in a vertical position and, on launch, the booster burns for up to 2.6 seconds before being jettisoned, while the sustainer burns for 19 seconds. The fire-control computer receives data from the 'Peel Group' radars as it tracks both target and missile and continually generates missile guidance commands which are communicated through a B-band (250 MHz-0.5 GHz) UHF uplink. The warhead is armed after the missile has travelled 50 m (164 ft), while the proximity fuze is activated by a command signal when the missile is 300 m (984 ft) from the launcher. If the missile fails to intercept, a further signal is sent either to change the trajectory or to self-destruct. SA-N-1 has a secondary anti-ship capability, with an effective range bracket of 4-9 n miles.

Specifications

Length: 6.1 m (20.0 ft)
Diameter: 37 cm (14.57 in)
Wing span: 1.2 m (3.94 ft)
Weight: 946-950 kg (2,085-2,094 lb)
Speed: Mach 3.5
Range: 1.33-16 n miles (2.5-30 km)

Summary

Weapon system	Weapon type	Type 61	Type 61M
Surface-to-surface missiles	SS-N-2 Styx	—	4
Surface-to-air missiles	SA-N-1 Goa	2	2
Guns	76 mm (3 in) AK-630	2 × 2 —	2 × 2 4
Torpedo tubes	533 mm (21 in)	5	5
ASW mortars	RBU 6000 RBU 1000	2 2	2 —
Minelaying capability	20 mines	Yes	No
Helicopter platform		No	Yes

Guidance: Radar command
Warhead: 60 kg (132 lb) HE fragmentation warhead
Fuzes: Contact and radar proximity

Manufacturer/Contractor

Fakel.

TORPEDOES

There is one PTA-53-61, five-tube 533 mm (21 in) torpedo launcher, sited midships immediately abaft the after stack, which launches torpedoes on either beam. It is used to launch the full range of Russian torpedoes.

GUNS

Two AK-726 twin 76 mm (3 in)/59 mountings

There are two twin AK-726 turrets, one at either end of the ship. The AK-726 is a multirole weapon system designed for air defence, surface engagement and shore bombardment roles and consists of two 76 mm guns mounted in a turret with a 5 mm metal shield. Each gun has its own loading system based upon a continuous supply of ammunition from an intermediate magazine on a below-decks platform under the turret, where ammunition from the main magazine is manually inserted into separate hoists, which carry the rounds into the turret and onto a feeder rail. As the gun recoils, the next round is brought forward for insertion into the breech and as it counter-recoils, a new round is brought in position for insertion in the next cycle. The whole mounting can contain 60 rounds of which two are on the feeder rail and four are on the hoists at any one time.

The prime ammunition is the UOFB-62, a fixed round which weighs 12.8 kg. The projectile weighs 4.6 kg (10 lb) and has 400 g of A-IX-2 explosive and a VG-67 point impact fuze.

There is a five-man crew in the turret: the gun captain, two layers and two loaders. There is a further team of four loaders in the below-decks magazine.

AK-726 is associated with 'Owl Screech' radar. In addition to radar fire control there is local control through the Prisma optical sighting system, which may be used for engaging targets with speeds of up to 600 m/s (Mach 1.75).

Specifications

Calibre: 76 mm
Length of barrel: 59 calibres
Muzzle velocity: 980 m/s (3,215 ft/s)
Traverse: 360° at 36°/s
Elevation: −7 to +85° at 32°/s
Ammunition (total): 16 kg (35.3 lb)
Rate of fire: 90 rds/min (whole mounting)
Range:
anti-surface: 8 n miles (15 km)
anti-air (max): 10,000 m (32,810 ft)
anti-air (effective): 7,000 m (22,967 ft)

30 mm/65 AK 630 Gatling-type close in weapons system

In the Kashin Mod only there are four 30 mm/54 calibre AK-630 Gatling close in weapon systems, which, somewhat surprisingly, are all located aft, grouped around the foot of the tower supporting the after 'Peel Group' director. These have five roles, engaging anti-ship missiles, aircraft, small surface vessels, drifting mines and unprotected targets ashore. The AO-18 weapon is a water-cooled, six-barrelled, Gatling-principle weapon with fixed breech block and revolving barrels. The weapon is believed to operate in a similar manner to that of the Phalanx, firing bursts of up to 400 rounds, but unlike the US weapon AK-630 features a separate radar director.

Specifications

Calibre: 30 mm
Length of barrel: 65 calibres
Number of barrels: 6
Muzzle velocity: 890 m/s (2,912 ft/s)
Cooling: Water
Traverse: 360° at 70°/s
Elevation: −12 to +88° at 50°/s
Crew: 1 (off mount)
Range: 4,000 m (radar fire control), 5,000 m (electro-optic fire control)
Rate of fire: 4,000-5,000 rds/min
Magazine: 2,000 rds
Weight of complete round: 1.224 kg (2.7 lb)
Ammunition types: UOF-84 HE-I weight 384 g (13.54 oz); UOR-84 HE-T weight 388 g (13.68 oz)
Fuze: MG-32 point impact (both rounds)

ANTI-SUBMARINE MORTARS

RBU-6000

Kashin and Kashin Mod have two sets of 12-tube RBU-6000s mounted on the roof of a deckhouse immeditaely forward of the bridge. The mounting can traverse through 360° and elevation limits are −15 to +60°. Loading is automatic from a below-deck magazine. It is estimated that the rockets weigh 110 kg (242.5 lb), with a 25 kg (55 lb) warhead. Pairs of tubes are fired in sequence. The RGB-60 rocket is fitted with an impact/time fuze, which detonates either on hitting a solid object (such as a submarine) or reaches a preset depth. Firing is usually conducted in a full salvo of 12 rockets, but it is also possible to fire single rockets, or four- or eight-rocket salvos, if the tactical situation requires it. The warhead weighs 31 kg (68.3 lb).

RBU 1000

(Kashin only.) The original Kashins only have two RBU-1000 anti-torpedo mortars, which are located in the waist below the 'Owl Screech' director tower. This mounting has a total of six rocket launcher tubes mounted three per side of a steel pedestal. The tubes may be trained through 360° and may be fired at angles up to 40°. Each launcher is 300 mm in diameter and 1.5 m long and is loaded automatically from a below-deck magazine which is about 2 m deep. For reloading, the tubes are raised to the vertical and the loading mechanism inserts the 90 kg rockets in sequence. The rockets, which feature a 55 kg warhead, have a range of approximately 0.5 n miles. In the less common stand-alone configuration the system may be associated with a small bow-mounted, active Medium Frequency (MF) search and attack sonar possibly the one given the NATO designation 'Bull Nose'. Associated sonar

systems when RBU 1000 complements RBU 6000 may be found under the latter entry.

Specifications

Launch tubes: 6
Tube arrangement: 2 vertical rows of 3
Calibre: 300 mm
Tube length: 1.8 m (5.9 ft)
Elevation: +40°
Traverse: 360°
Rocket weight: 90 kg (198 lb)
Warhead: 55 kg (121 lb)
Range: 0.5 n miles (1,000 m)

MINES

Kashin only. The original 'Kashin' class only has a capability to carry a maximum of 20 mines, which are laid over the stern.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

Bell Shroud

Kashin Mod only has two Bell Shroud ESM antennas, which is basically a Watch Dog B system with two extra pairs of receiver antennas to cover higher frequencies in the radar spectrum. Bell Shroud is the standard intercept system used on destroyers and frigates of the Russian Navy, and is used in conjunction with Bell Squat as the standard intercept/jamming system.

Bell Squat

Kashin Mod only has two Bell Squat antennas. This equipment was derived from Top Hat with the frequency bands increased to cover K-band. Two types of ECM system are in use, Bell Squat A which uses barrage jamming, and Bell Squat B which employs deception jamming.

Watch Dog

(Kashin only). The original Kashins have two Watch Dog intercept and radar warning systems. This is an elderly system. It is a wide-open system with an array which consists of four tiers of eight microwave horns, covering the frequency range from D- to H-band and normally has two antennas, one on each side of the ship.

DECOYS

Kashin Mod only has four 16-tubed chaff launchers. Kashin and Kashin Mod each have two towed torpedo decoys.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Tee Plinth optronic directors

There are three Tee Plinth optronic directors. These are television monitors, with the camera under an armoured protective helmet to enable the officers in the combat information centre to observe what is going on.

Tilt Pot optronic directors

Four Tilt Pot fixed TV monitors.

RADARS

IFF: High Pole B (modified).

HEAD NET C air surveillance radar

This E-band, 3D radar is the height-finder for the SA-N-1 missile system. It consists of two back-to-back Head Net A scanners, with one of the scanners tilted at some 30° to the horizontal. This displaces the resulting fan-shaped elevation beam by the same amount from the vertical, which, in combination with the vertical beam produced by the companion scanner, provides the means for height-finding using the 'V-beam' technique. The two beams are also separated in azimuth by 180°. In practice, the vertical beam fulfils the search function and the operator selects a target for which height data is required, and by placing a marker on this target (or similar technique) he places a range gate in the second (inclined) beam and excludes other targets. Computation to give a height readout can then be performed by analogue or digital methods.

BIG NET long-range 3D air surveillance radar

Big Net is mounted on top of the main mast in both Kashin and Kashin Mod. It is a very large, long-range air surveillance radar operating in D/E-band. Beamwidth is 5° and scan rate between 6 and 8 rpm. The open lattice reflector is of elliptical parabolic form, illuminated by an underslung horn feed carried on a solid boom, and with two balance vanes behind it. Range performance is estimated as more than 100 n miles (185 km) against an aircraft at medium altitude, and up to 200 n miles (370 km) at higher altitudes.

Two navigation radars

All these ships carry two navigation radars, although various models have been seen including Don 2, Don Kay and Palm Frond.

All these operate at between 9,400 and 9,600 MHz (I-band).

Peel Group

Peel Group is the H/I-band (6-10 GHz) monopulse fire-control radar for the SA-N-1 SAM system. It features two pairs of solid reflectors, one large and one small, with one pair in the vertical plane and the other in the horizontal plane. They are grouped around a prominent conical lattice antenna which is believed to be for command guidance signals and together they probably provide tracking in three co-ordinates. The larger antennas may be for long-range target acquisition and 'coarse' tracking while the smaller ones probably provide precision tracking at closer ranges. The practical range of this system is believed to be 8 to 11 n miles (15 to 20 km) with one target engaged per launcher although two missiles may be launched at each target.

Owl Screech gunfire control radar

There are two Owl Screech gunfire control directors for the 76 mm guns. Owl Screech is a fire-control radar of conventional design, widely used in many classes of vessels, distinguished by a circular dish scanner, behind which is mounted a fairly bulky housing which is assumed to contain transmitter and receiver, and probably turning and stabilisation gear. The complete radar is pedestal-mounted. The 2.3 m diameter scanner has a central feed supported by a four-leg structure. Feed arrangements could incorporate a rotating dipole to provide a conical scan search pattern. Dish diameter is approximately 2 m and the operating frequency is in the H/I-band.

The NATO designation Owl Screech is derived from signal characteristics noted in the course of ELINT monitoring.

The principal function is that of gunfire director against aircraft targets, although this type probably also has a certain capability against surface targets, and possibly splash detection.

Bass Tilt

Bass Tilt is an H-band system with its director mounted on a pedestal and its antenna with a drum-shaped radome 1.2 m (3.9 ft) in diameter inclined at an angle of approximately 45°. The director is 2 m (6.5 ft) high and 1.45 m (4.75 ft) long. The radar is probably linked to a ballistic computer and each director controls up to two AK-630 gun mountings. In addition to the radar there is a fallback optical and/or electro-optical control system, the latter possibly based upon the sensor with the NATO code-name 'Tee Plinth'.

SONARS

Bull Nose/Wolf Paw

The Kashins may be fitted with either Bull Nose or Wolf Paw, both of which are hull-mounted, active search and attack sonars. Wolf Paw is the elder of the two and is the surface-ship version of the Herkules sonar, widely used in Soviet submarines in the 1960s and 1970s. Bull Nose was the successor to Wolf Paw and is an MF (7-8 kHz) bow-mounted sonar.

Mare Tail

Kashin Mod only has Mare Tail, a stern-mounted VDS which first appeared in the 'Kashin Mod' class. It is a medium-frequency search sonar and is known in the Russian Navy as Vega.

AVIATION

AVIATION FACILITIES

(Kashin Mod only)

Specifications

Flight deck: 20 × 15.8 m (66 × 51.8 ft)

HELICOPTERS

In view of the lack of a hangar it appears that helicopters are not permanently assigned to Kashin Mod ships, but both Kamov Ka-25s and Ka-27s have been observed aboard such ships.

PROPULSION

Specifications

System: Combined gas turbine and gas turbine (COGAG)
Main machinery: 4 DE 59 gas turbines; 52.9 MW (72,000 hp (m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

Before the 'Kashin' class the Soviet Navy had followed other countries' leads in warship design, with Italy and Germany having exerted particularly strong influences. With the 'Kashin' class, however, they moved firmly into the ranks of the world leaders and for the next thirty years every new Soviet design was awaited with great interest (and not a little concern) in the West.

The 'Kashin' class was built to replace the 'Kotlin' and 'Riga' class destroyers, with the first of class being completed in 1964 and followed by 18 more, with five being built at the Zhdanov yard and the remainder at Nikolayev, production ending in 1972. One more ship, *Sderzhanny*, was then built to a modified design, designated Projekt 61M in Russia (NATO = Kashin Mod) and five of the original Kashins were subsequently converted to the same standard.

Of the 20 ships originally built for the Soviet Navy, one *(Smely)* was transferred to Poland in 1987 and the remainder had been stricken by 1996, with the exception of one of the original design *(Skory)* and the prototype of the modified ships *(Sderzhanny)*. Four ships were built for the Indian Navy as Project 61ME, all of which remain in service.

Skory *is the last of the unmodified 'Kashin' class destroyers to remain in service with the Russian Navy; note the absence of a helicopter flight deck* (H & L van Ginderen Collection)

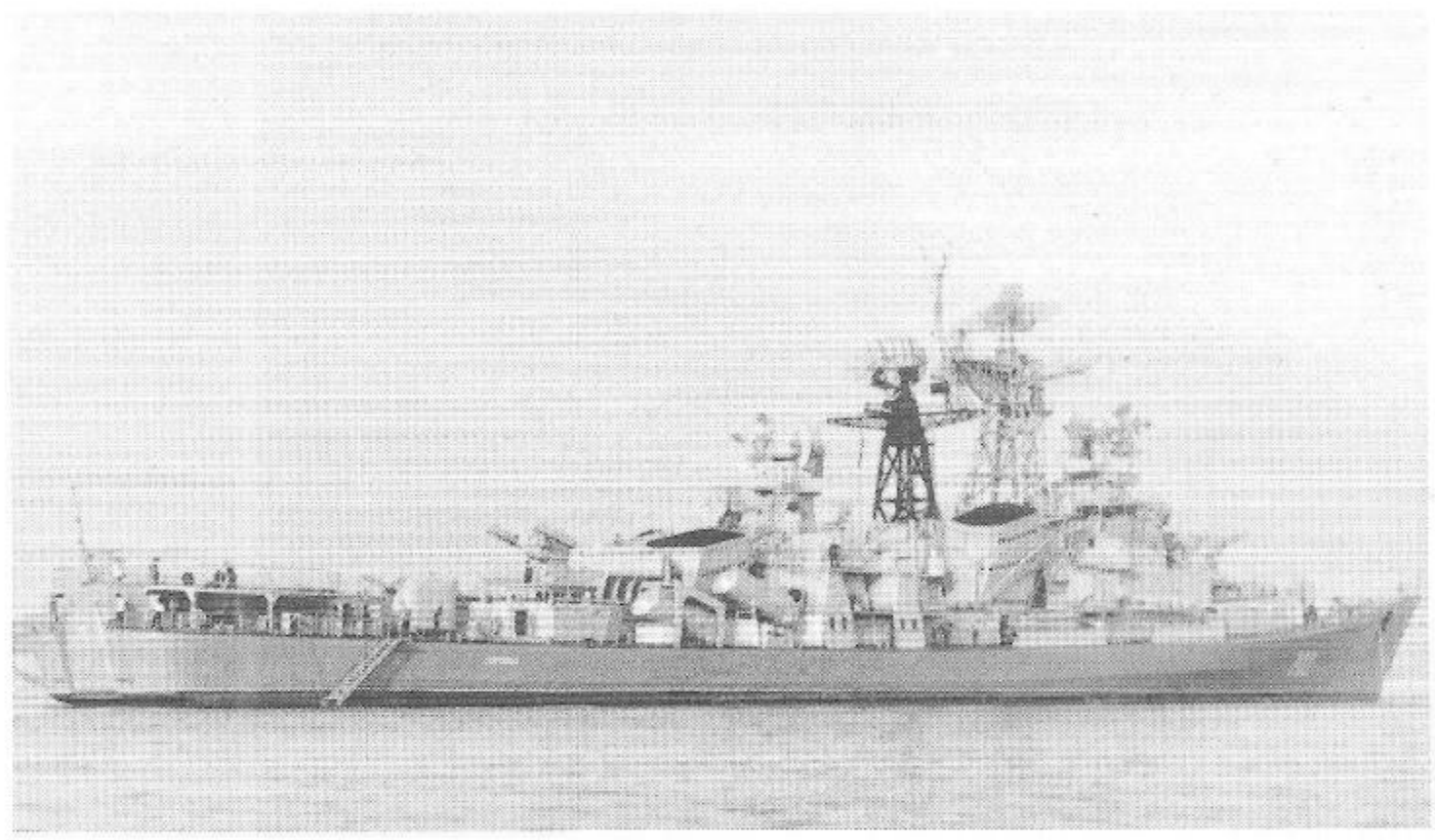
DESIGN

The 'Kashin' class were the first warships in the world to be powered exclusively by gas turbines, a Soviet innovation which was years ahead of the West, where a few navies were just starting to experiment with gas-turbine propulsion, but usually in combination with steam or diesels. In the Soviet design, four large industrial gas turbines were used, each producing some 24,000 shp, with the uptakes being led up to four relatively short stacks, which were angled outwards to keep the hot gases clear of the various antennas on the masts. The exhaust gases were also cooled by mixing them with air in the stack. The electric power generators were also gas turbines. One of the consequences of this power arrangement was that the Kashins could accelerate from rest to cruising speed in 10 minutes and to maximum speed (34 knots) in a further 6 to 8 minutes, a performance no steam turbine-driven warship could even approach.

The hull was also of a new design, with very fine lines forward and a pronounced knuckle running from just below the forward missile launcher to the stern. Above the knuckle the hull had a negative angle (tumblehome) which was an early form of radar signal deflector, designed to reduce the radar cross-section (RCS).

The Kashins were also the first Soviet ships to have a 'double-ended' missile installation, with one SA-N-2 Goa launcher and magazine forward of the bridge and a second set atop a deckhouse aft.

Sderzhanny, last of the class, was built to a modified design.



Sderzhanny *remains in service, the last of the modified 'Kashin' class. It is 2.2 m (7.3 ft) longer than* Skory, *has a revised armament, including four aft-firing SS-N-2c Styx, and a helicopter flight deck* (H & L van Ginderen Collection)

MODERNISATION

In order to bring this class up to date with SSM and VDS a conversion programme was started in 1972 to the same pattern as set in *Sderzhanny.* This conversion consisted of lengthening the hull by 2.2 m (7.3 ft), shipping four SS-N-2c launchers (SSM), four Gatling close-range weapons, a VDS under a new stern helicopter platform and removing the after RBUs.

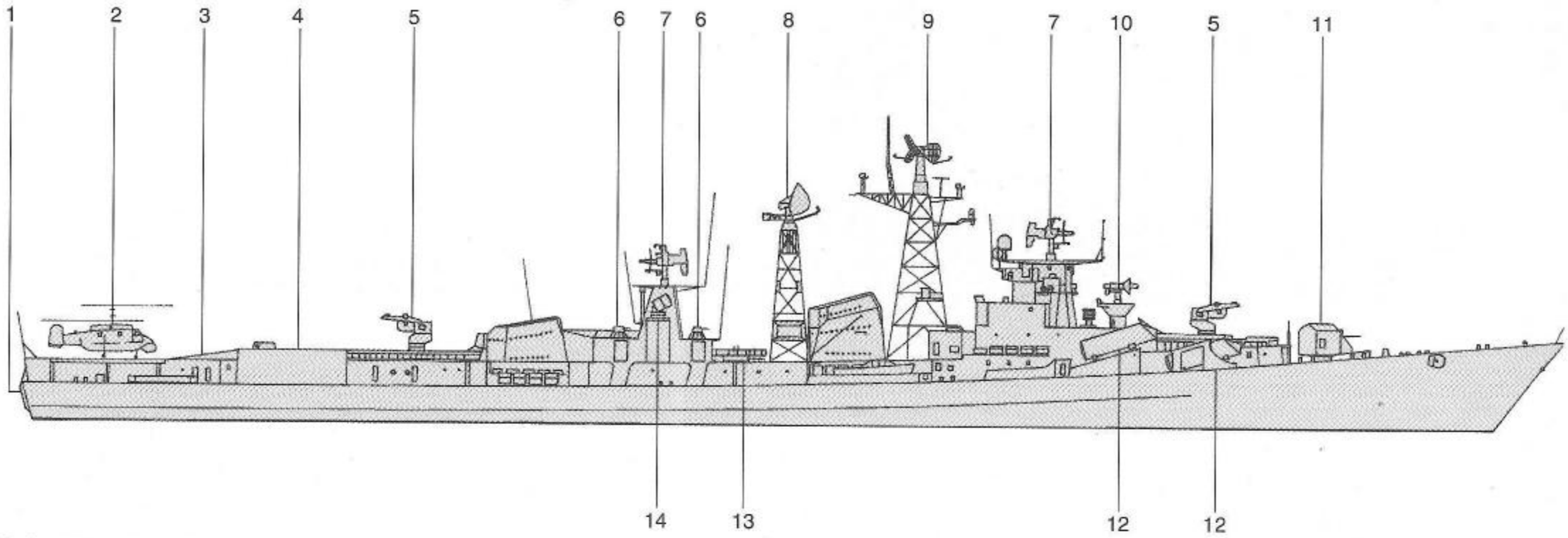
THE FUTURE

Only two now remain in service, both being based in the Black Sea.

OPERATIONAL

One ship, *Orel,* sank in the Black Sea in 1974.

RAJPUT (KASHIN II)



Rajput (Ian Sturton)
1 *Hosta VDS* **2** *Kamov Ka-27 Helix* **3** *Flight deck* **4** *Hangar (below deck)* **5** *SA-N-1 Goa twin launcher* **6** *Twin 30 mm/65 in* Rajput, Rana, Ranjit *(four each), 30 mm ADG-630 Gatling in* Ranvir, Ranvijay *(four each)* **7** *Peel Group fire control* **8** *Big Net A radar (air search)* **9** *Head Net C radar (air/surface search)* **10** *Owl Screech fire control (76 mm guns)* **11** *Twin 76 mm/60 gun mounting* **12** *SS-N-2d Styx SSM* **13** *533 mm (21 in) torpedo tubes (five)* **14** *Drum Tilt in* Rajput, Rana, Ranjit *(two each) Bass Tilt in* Ranvir, Ranvijay (two each)

GENERAL SPECIFICATIONS

Country of origin: Russia
Operator: India
Type: Type 61ME

Class: RAJPUT (KASHIN II)

Purchased: 5
Active: 5

Displacement:
standard: 3,950 t
full load: 4,974 t

Dimensions
Length: 146.5 m (480.5 ft)
Beam: 15.8 m (51.8 ft)
Draught: 4.8 m (15.7 ft)

Speed: 35 kts
Range: 4,500 n miles at 18 kts; 2,600 n miles at 30 kts

Complement: 320 (35 officers)

SHIPS

RAJPUT (D 51)
Builder Kommuna, Nikolayev, Russia
Launched Sep 1977
Commissioned 30 Sep 1980

RANA (D 52)
Builder Kommuna, Nikolayev, Russia
Launched Oct 1978
Commissioned 28 Jun 1982

RANJIT (D 53)
Builder Kommuna, Nikolayev, Russia
Launched Jun 1979
Commissioned 24 Nov 1983

RANVIR (D 54)
Builder Kommuna, Nikolayev, Russia
Launched Mar 1983
Commissioned 28 Aug 1986

RANVIJAY (D 55)
Builder Kommuna, Nikolayev, Russia
Launched Feb 1986
Commissioned 15 Jan 1988

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

P-22 Rubezh (SS-N-2d 'Styx') medium-range anti-ship missile

The Indian ships are armed with four P-22 (NATO = SS-N-2d 'Styx') missiles with two single aft-facing launch bins one behind the other on either side of the after stack. There are no relaods. The P-22 missile was introduced into service in 1967 and is essentially a P-20 (also designated SS-N-2a) with an added infra-red seeker. This relatively large anti-ship missile is powered by a liquid-fuelled rocket motor, with a solid fuel booster attached, and flies at Mach 0.9.

Once the target is detected, the ship must close with the aim of being within the optimum engagement distance, some 15 to 20 n miles (28 to 37 km). Then, since the missile launcher must face the target, the ship must turn away and, while maintaining a speed of 15 knots or less, hold its course for 20 to 30 seconds before launching the first salvo of two missiles. These may be followed, a minute later, by another two.

Upon launch, the missile climbs at an angle of 45° to one of five preset altitudes (100, 150, 200, 250 or 350 m), where the onboard radar searches for a target and the receiver is switched on for very short periods to receive signals from a designated range, the range gate being 1 km on either side of the target. The radar locks on only after eight returns have been received, at distances of 3.5 to 12 n miles (6.5 to 22 km), whereupon the seeker guidance system switches off the autopilot. A throw-off gyroscope takes the missile on target a few seconds before impact as it becomes too close for radar-generated homing signals. Russian Navy tacticians calculate that seven to eight missiles are required to destroy a cruiser-size target and four for a destroyer, making salvo firing a major feature of any tactical engagement scenario with SS-N-2c missiles to ensure destruction of the target.

Specifications

(SS-N-2d)
Length: 6.55 m (21.49 ft)
Diameter: 76 cm (30 in)
Wing span: 2.4 m (7.87 ft)
Speed: Mach 0.9
Weight (without booster): 2,600 kg (5,732 lb)
Warhead: 454 kg (1,000 lb) hollow-charge
Fuzes: Impact, proximity
Range: 3-54 n miles (5.5-100 km)
Guidance: Autopilot with active radar (supplemented in some with IR)

MS-2 seeker
Frequency: I-band (8-12 GHz) (four presets)
PRF: 300-500 pps (adjustable)
Altitude control: Barometric pressure device

Manufacturer/Contractor

Raduga, Moscow, Russia.

SURFACE-TO-AIR MISSILES (SAM)

M-1 Volnya (NATO = SA-N-1 'Goa') air defence system

There are two SA-N-1 twin-arm, stabilised, launchers, each with a 16-round magazine. SA-N-1 is a naval version of the Soviet Army's SA-3 and is a command-guided missile with a speed of Mach 3. The missiles are loaded hydraulically with the launch rails in a vertical position and on launch the booster burns for up to 2.6 seconds before being jettisoned, while the sustainer burns for 19 seconds. The fire-control computer receives data from the 'Peel Group' radars as it tracks both target and missile and continually generates missile guidance commands, which are communicated through a B-band (250 MHz-0.5 GHz) UHF uplink. The warhead is armed after the missile has travelled 50 m (164 ft), while the proximity fuze is activated by a command signal when the missile is 300 m (984 ft) from the launcher. If the missile fails to intercept, a further signal is sent either to change the trajectory or to self-destruct. SA-N-1 has a secondary anti-ship capability.

Specifications

Length: 6.1 m (20 ft)
Diameter: 37 cm (14.57 in) (missile); 55 cm (21.65 in) (booster)
Wing span: 1.2 m (3.94 ft)
Weight: 946-950 kg (2,085-2,094 lb)

Rana *(D 52). These Indian ships are the only versions of the Kashin design to have the SS-N-2 Styx missile launchers before the bridge; all others have them aft, firing over the stern* (H & L van Ginderen Collection)

Speed: Mach 3.5
Range: 1.33-16 n miles (2.5-30 km)
Guidance: Radar command
Warhead: 60 kg (132.3 lb) HE fragmentation warhead
Fuzes: Contact and radar proximity

Manufacturer/Contractor
Fakel.

TORPEDOES

There is one PTA-53-61, five-tube 533 mm (21 in) torpedo launcher sited midships immediately abaft the after stack which launches torpedoes on either beam. The Indian Navy uses Type 53-65 torpedoes.

Specifications
Type 53-65
Role: Anti-surface ship
Diameter: 533 mm (21 in)
Length: 7.8 m (25.6 ft)
Propulsion: Turbine
Speed: 50 kts
Range: 13 n miles (25 km)
Guidance: Passive/wake
Warhead: 300 kg (661 lb)

GUNS

One AK-726 twin 76 mm (3 in)/59 mounting
There is one twin AK-726 turret forward of the bridge. The AK-726 is a multirole weapon system designed for air defence, surface engagement and shore bombardment roles and consists of two 76 mm guns mounted in a turret with a 5 mm metal shield. Each gun has its own loading system based upon a continuous supply of ammunition from an intermediate magazine on a below-decks platform under the turret, where ammunition from the main magazine is manually inserted into separate hoists, which carry the rounds into the turret and onto a feeder rail. As the gun recoils the next round is brought forward for insertion into the breech and as it counter-recoils a new round is brought in position for insertion in the next cycle. The whole mounting can contain 60 rounds of which two are on the feeder rail and four are on the hoists at any one time.

The prime ammunition is the UOFB-62, a fixed round which weighs 12.8 kg (28.2 lb). The projectile weighs 4.6 kg (10 lb) and has 400 g (10 lb) of A-IX-2 explosive and a VG-67 point impact fuze.

There is a five-man crew in the turret: the gun captain, two layers and two loaders. There is a further team of four loaders in the below-decks magazine.

AK-726 is associated with 'Owl Screech' radar. In addition to radar fire control there is local control through the Prisma optical sighting system, which may be used for engaging targets with speeds of up to 600 m/s (Mach 1.75).

Specifications
Calibre: 76 mm (3 in)
Length of barrel: 59 calibres
Muzzle velocity: 980 m/s (3,215 ft/s)
Traverse: 360° at 36°/s
Elevation: −7 to +85° at 32°/s
Ammunition weight (total): 16 kg (35.3 lb)
Projectile: 6.8 kg (15 lb)
Rate of fire: 90 rds/min (whole mounting)
Range:
anti-surface: 8 n miles (15 km)
anti-air (max): 10,000 m (32,810 ft)
anti-air (effective): 7,000 m (22,967 ft)

30 mm L/65 AK-230 twin mounting
The first three ships, *Rajput, Rana* and *Ranjit,* are armed with four AK-230 twin 30 mm mounts, which were substituted for the AK-630s installed in the Soviet Navy's Kashin (although the AK=230s were restored in the last two Indian ships — see below). The AK-230 is a remotely operated, twin barrel, automatic anti-aircraft gun designed to engage air targets at heights of up to 4,000 m (13,000 ft). It is also capable of engaging surface targets at ranges up to 2.2 n miles (4 km). The electrically powered mounting consists of two 64.2 calibre, water-cooled, NN-30 guns, each with a liner and a rotating breech with four chambers. The elevating mechanism is on the carriage together with a compressed air tank and associated equipment for the loading system. Russian ammunition for this weapon consists of two rounds; BR-83 and OF-83D (see Specifications).

Propellant gas ducted from the breech ejects the empty cartridge case and the rotating breech moves the next chamber into line with the gun. With every round fired, coolant is injected into the barrels, the liners and the front of the revolving breech. During intensive firing, nitrogen gas is blown into the breech opening to prevent the accumulation of explosive gases. Recoil forces are used to move empty cartridges and belt links, together with misfired rounds, into a storage space between the base ring and the magazine.

The fire-control radar is the I/J-band Rys (NATO = Drum Tilt) fire-control radar, whose maximum acquisition range is approximately 40 km (22 n miles), with each radar director controlling two gun mountings.

Specifications
NN-30 gun
Calibre: 30 mm
Length of barrel: 64.2 calibres
Muzzle velocity: 1,050 m/s (3,445 ft/s)
Range:
anti-surface: 2.2 n miles (4 km)
anti-air: 4,000 m (13,000 ft)
Rate of fire: 1,000 rds/min/gun

Mounting
Traverse: 360° at 70°/s
Elevation: −12 to +87° at 50°/s
Crew: 2 (off mount)

Ammunition
BR-83:
type: armour-piercing tracer
weight (complete round): 1.47 kg (3.24 lb)
weight (projectile): 0.35 kg (12 oz)
OF-83D:
type: high explosive
weight (complete round): 1.40 kg (3.09 lb)
projectile: 0.27 kg (9 oz)
explosive: 0.3 kg (10 oz) (A-XI-2)

30 mm/65 AK 630 Gatling-type close in weapons system
In the last two ships, *Ranvir* and *Ranvijay,* four 30 mm/65 calibre AK-630 Gatling close in weapons systems were installed in place of the AK-230s in the first four. This meant that the two Indian ships had the same air defence guns as their Soviet counterparts. All four are located aft, grouped around the foot of the tower supporting the after 'Peel Group' director. These have five roles, engaging anti-ship missiles, aircraft, small surface vessels, drifting mines and unprotected targets ashore. The AO-18 weapon is a water-cooled, six-barrelled, Gatling-principle weapon with fixed breech block and revolving barrels. The weapon is believed to operate in a similar manner to that of the Phalanx, firing bursts of up to 400 rounds, but unlike the US weapon AK-630 features a separate radar director, Drum Tilt.

Specifications
AO-18 gun
Calibre: 30 mm
Length of barrel: 65 calibres
Number of barrels: 6
Muzzle velocity: 890 m/s (2,920 ft/s)
Cooling: Water
Range: 4,000 m (13,000 ft) (radar fire control), 5,000 m (16,400 ft) (electro-optic fire control)
Rate of fire: 4,000-5,000 rds/min
Magazine: 2,000 rds

Mounting
Traverse: 360° at 70°/s
Elevation: −12 to +88° at 50°/s
Crew: 1 (off mount)

Ammunition
Weight of complete round: 1.224 kg (2.70 lb)
Ammunition types: UOF-84 HE-I, weight 384 g; UOR-84 HE-T, weight 388 g
Fuze: MG-32 point impact (both rounds)

ANTI-SUBMARINE MORTARS

RBU-6000
Two sets of 12-tube RBU-6000s are mounted on the roof of a deckhouse immediately forward of the bridge. The mounting can traverse through 360° and elevation limits are −15 to +60°. Loading is automatic from a below-deck magazine. It is estimated that the rockets weigh 110 kg (242 lb), with a 25 kg (55 lb) warhead. Pairs of tubes are fired in sequence. The RGB-60 rocket is fitted with an impact-time fuze, which detonates either on hitting a solid object (such as a submarine) or reaches a preset depth. Firing is usually conducted in a full salvo of 12 rockets, but it is also possible to fire single rockets, or four- or eight-rocket salvos, if the tactical situation requires it.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

Bell Clout/Bell Slam/Bell Tap

The first three ships, *Rajput, Rana* and *Ranjit,* are fitted with three ESM equipments:

Bell Clout: 'Bell Clout' covers a relatively narrow frequency range in K-band, and is frequently to be found operating in tandem with 'Bell Slam'.

Bell Slam: 'Bell Slam' is a threat warning system and is an offshoot of 'Bell Tap', but with a larger frequency coverage.

Bell Tap: 'Bell Tap' was developed primarily because of the need for an over-the-horizon targeting capability. It is a directional ESM system, covering the G, H and I-frequency bands. It is mast mounted and uses a large antenna, giving an accuracy in bearing of about 2.5°.

Bell Squat/Bell Shroud

The last pair of ships, *Ranvir* and *Ranvijay,* have a different ESM/ECM suite, consisting of:

Bell Squat: There are two 'Bell Squat' jammer systems, which were derived from 'Top Hat', but with the frequency bands increased to cover K-band. Two types of ECM system are in use, 'Bell Squat A' which uses barrage jamming, and 'Bell Squat B' which employs deception jamming.

Bell Shroud: There are also two 'Bell Shroud' systems, which are basically 'Watch Dog B's, each with two extra pairs of receiver antennas to cover higher frequencies in the radar spectrum. It is the standard intercept system used in Russian destroyers and frigates and is used in conjunction with 'Bell Squat' as the standard intercept/jamming system.

DECOYS

Four PK-16 16-barrelled chaff launchers for radar decoy and distraction.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS AND DATALINKS

IFF: Two High Pole B.
Satcom. Inmarsat.

RADARS

Big Net A long-range 3D air surveillance radar

'Big Net A' is mounted on top of the main mast in both Kashin and Kashin Mod. It is a very large, long-range air surveillance radar operating in C-band. Beamwidth is 5° and scan rate between 6 and 8 rpm. The open lattice reflector is of elliptical parabolic form, illuminated by an underslung horn feed carried on a solid boom, and with two balance vanes behind it. Range performance is estimated as more than 100 n miles (185 km) against an aircraft at medium altitude, and up to 200 n miles (370 km) at higher altitudes.

Head Net C air surveillance radar

This E-band, 3D radar is the height-finder for the SA-N-1 missile system. It consists of two back to back 'Head Net A' scanners, with one of the scanners tilted at some 30° to the horizontal. This displaces the resulting fan-shaped elevation beam by the same amount from the vertical, which, in combination with the vertical beam produced by the companion scanner, provides the means for height-finding using the 'V-beam' technique. The two beams are also separated in azimuth by 180°. In practice, the vertical beam fulfils the search function and the operator selects a target for which height data is required, and by placing a marker on this target (or similar technique) he places a range gate in the second (inclined) beam and excludes other targets. Computation to give a height readout can then be performed by analogue or digital methods.

Don Kay

All Indian Kashin IIs carry two 'Don Kay' navigation radars, operating at between 9,400 and 9,600 MHz (I-band).

Peel Group

'Peel Group' is the H/I-band (6-10 GHz) monopulse fire-control radar for the SA-N-1 SAM system. It features two pairs of solid reflectors, one large and one small, with one pair in the vertical plane and the other in the horizontal plane. They are grouped around a prominent conical lattice antenna which is believed to be for command guidance signals and together they probably provide tracking in three co-ordinates. The larger antennas may be for long-range target acquisition and 'coarse' tracking while the smaller ones probably provide precision tracking at closer ranges. The practical range of this system is believed to be 8 to 11 n miles (15 to 20 km) with one target engaged per launcher although two missiles may be launched at each target.

Owl Screech gunfire control radar

There is one 'Owl Screech' gunfire control director for the 76 mm guns. 'Owl Screech' is a fire-control radar of conventional design, widely used in many classes of vessels, distinguished by a circular dish scanner, behind which is mounted a fairly bulky housing which is assumed to contain transmitter and receiver, and probably turning and stabilisation gear. The complete radar is pedestal mounted. The 2.3 m (7.5 ft) diameter scanner has a central feed supported by a four-leg structure. Feed arrangements could incorporate a rotating dipole to provide a conical scan search pattern. Dish diameter is approximately 2 m (6.5 ft) and the operating frequency is in the H/I-band.

The NATO designation 'Owl Screech' is derived from signal characteristics noted in the course of ELINT monitoring.

The principal function is that of gunfire director against aircraft targets, although this type probably also has a certain capability against surface targets, and possibly splash detection.

Drum Tilt

There are two 'Rys' (NATO = 'Drum Tilt') fire-control systems in *Rajput, Rana* and *Ranjit* for the AK-230. This is an I/J-band system with a pedestal-mounted director whose antenna is in a weatherproof container attached to the scanner assembly and tilted at an angle of about 22°. The maximum acquisition range is approximately 22 n miles (40 km). One radar director usually controls up to two gun mountings.

Bass Tilt

'Bass Tilt' is the gunfire control system for the AK-630 Gatlings and is fitted in *Ranvir* and *Ranvijay* only. 'Bass Tilt' is an H-band system with its director mounted on a pedestal and its antenna with a drum-shaped radome 1.2 m in diameter inclined at an angle of approximately 45°. The radar is probably linked to a ballistic computer and each director controls up to two AK-630 gun mountings. In addition to the radar there is a fallback optical and/or electro-optical control system, the latter possibly based upon the sensor with the NATO code-name 'Tee Plinth'.

SONARS

Vycheda MG 311

This is presumed to be the same sonar as that known to NATO as 'Bull Nose'. It is a hull-mounted, medium-frequency, active search and attack system.

Mare Tail

The variable depth sonar is known as Hosta (NATO = 'Mare Tail').

Ranvijay *(D 55). These five Russian-built destroyers make a substantial contribution to the power of the Indian Navy in the Indian Ocean. The Kamov Ka-28 Helix on the flight deck reaches its hangar using an elevator*

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 20 × 15.8 m (66 × 51.8 ft) (approximate)
Hangar: The hangar is partially below decks in the position previously occupied by the after twin 76 mm gun and its magazine. To reach it, the helicopter must move from the flight deck up a small ramp onto an elevator which then takes it down to the hangar

HELICOPTERS

This class is almost always seen at sea with a single Ka-27/28 Helix embarked.

Kamov Ka-27PL (NATO = Helix A)

Specifications
Rotor diameter: 15.90 m (52.16 ft)
Rotor disc area: 397 m² (4,275 sq ft)
Fuselage length: 11.30 m (37.07 ft)
Height to rotor head: 5.40 m (17.72 ft)
Operating weight, empty: 6,500 kg (14,330 lb)
Max take-off weight: 12,600 kg (27,778 lb)
Max payload: 5,000 kg (11,023 lb)
Max level speed at optimum altitude: 135 kts (250 km/h)
Endurance: 4.5 h
Engines: 2 Klimov (Isotov) TV3-117V turboshafts, each 1,645 kW (2,205 shp)
Accommodation: 3 (pilot plus 2)
Sensors: Surface search radar, sonobuoys, dipping sonar
Weapons: 2 Whitehead A244S or Russian APR-2 torpedoes, or 4 conventional depth bombs or mines

PROPULSION

Specifications
System: Combined gas turbine and gas turbine (COGAG)
Main machinery: 4 DE 59 gas turbines; 53 MW (72,000 hp (m))
Auxiliary power: 4 GTU-6A, 600 kW; 2 7D12, 200 kW
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The Indian Navy became autonomous on Independence in 1947 and for some 30 years tended to rely on British-designed ships, initially ex-Royal Navy ships, then new ships built in British yards, leading eventually to British designs built in Indian yards. Then, however, came a switch to Russian designs and in the mid-1970s the Indian Navy ordered a batch of three Kashin II destroyers, the first of which was handed over in September 1980. That was followed by an order for a second batch of two which were ordered on 20 December 1982 with the first handed over in August 1986. It is likely that one will be withdrawn from service soon.

DESIGN

One of the surprising aspects of this order was that when the Indians placed their order in the mid-1970s the Kashin was already a somewhat elderly design, having been on the drawing boards in the late 1950s and the last ship for the then Soviet Navy having been delivered in 1973. However, the Indian ships were all new construction and incorporated numerous modifications.

The Indian ships have a flight deck similar to that of the Russian Kashin Mod, but they also have a hangar, space for which was created by moving the SS-N-2D launchers forward to just before the bridge and deleting the after 76 mm gun.

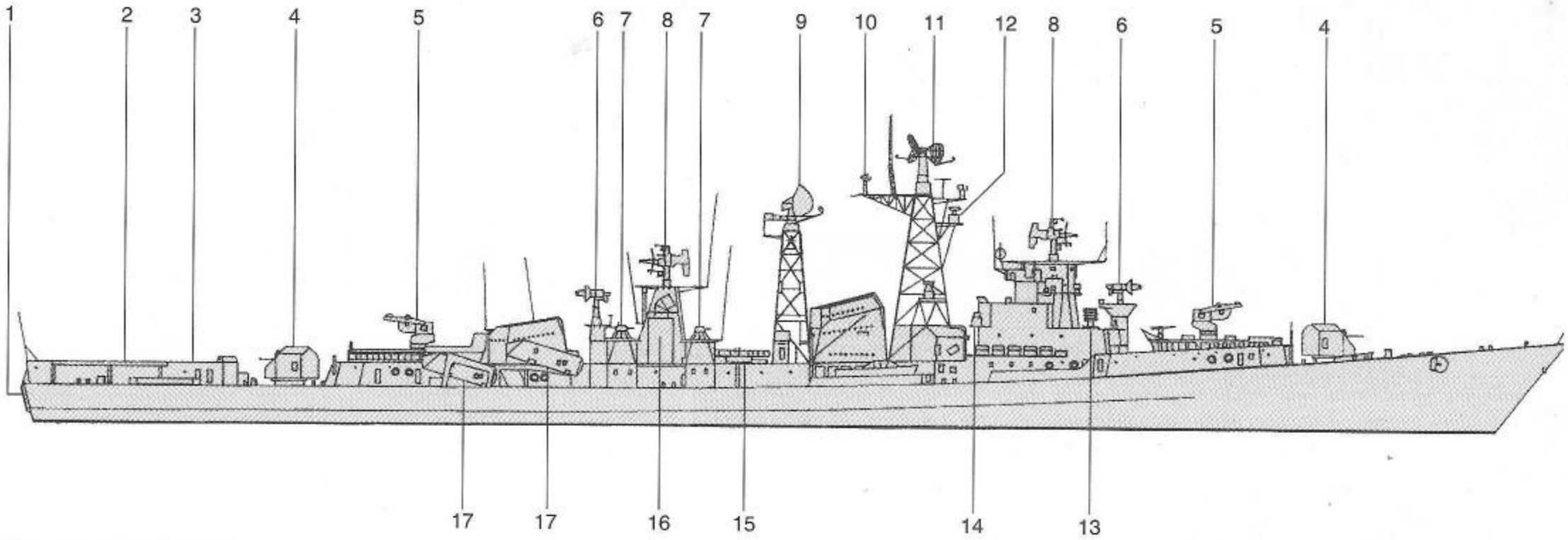
Ranvir and *Ranvijay* differ from the previous ships in the class in being fitted with ADGM-630 30 mm guns and two Bass Tilt fire-control radars; there are also many minor differences in electronic equipment.

It is possible that an Italian combat data system compatible with Selenia (now Alenia) IPN-10 is installed. Inmarsat has been fitted, the antenna being mounted behind the forward Peel Group director.

MODERNISATION

New EW equipment was fitted in 1993/94.

WARSZAWA (KASHIN Mod)



Warszawa (Ian Sturton)
1 Mare Tail VDS **2** *Flight deck* **3** *Hangar (reached by elevator)* **4** *AK-726 76 mm (3 in)/60 twin gun mounting* **5** *SA-N-1 Goa twin-arm launcher* **6** *Owl Screech fire control (for 76 mm guns)* **7** *AK-630 six barrelled 30 mm/65 Gatling CIWS (two)* **8** *Peel Group fire control (for SA-N-1)* **9** *Big Net radar (air/surface search)* **10** *SRN-207 radar (navigation)* **11** *Head Net C radar (3D air search)* **12** *SRN-7453 radar (navigation)* **13** *RBU-6000 anti-submarine rocket launcher (two)* **14** *Bell Shroud ECM (two)* **15** *Five 533 mm (21 in) torpedo tubes* **16** *Bass Tilt fire director (for AK-630) (two)* **17** *SS-N-2c (Styx) SSM (four)*

GENERAL SPECIFICATIONS

Country of origin: Russia
Operator: Poland
Type: 61MP

Class: WARSZAWA (KASHIN MOD)

Purchased: 1
Active: 1

Displacement:
standard: 3,850 t
full load: 4,950 t

Dimensions
Length: 146.2 m (479.7 ft)
Beam: 15.8 m (51.8 ft)
Draught: 4.84 m (15.88 ft)

Speed:
max: 35 kts
cruise: 18 kts
Range: 2,700 n miles at 30 kts; 5,000 n miles at 18 kts

Complement: 335 (20 officers)

SHIPS

WARSZAWA (271)

Builder	61 Kommunar Yard, Nikolayev, Ukraine	**Launched**	1969
		Commissioned (Russia)	7 Nov 1969 *(Smely)*
Laid down	1967	**On loan to Poland**	9 Jan 1988
		Sold to Poland	1993

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

P-21 Rubezh (SS-N-2c 'Styx') medium-range anti-ship missile

Warszawa is armed with four P-21/P-22 (NATO = SS-N-2c 'Styx') missiles with two single aft-facing launch bins one behind the other either side of the after stack. There are no reloads. The P-21 missile was introduced into service in 1967 and is essentially a P-15 (SS-N-2a) with an added infrared seeker. This relatively large anti-ship missile is powered by a liquid-fuelled rocket motor, with a solid fuel booster attached.

Once the target is detected the ship must close with the aim of being within the optimum engagement distance, some 15 to 20 n miles (28 to 37 km). Then, since the missile launcher must face the target the ship must turn away and, while maintaining a speed of 15 knots or less, hold its course for 20 to 30 seconds before launching the first salvo of two missiles. These may be followed, a minute later, by another two.

Upon launch the missile climbs at an angle of 45° to one of five preset altitudes (100, 150, 200, 250 or 350 m), where the onboard radar searches for a target and the receiver is switched on for very short periods to receive signals from a designated range, the range gate being 1 km on either side of the target. The radar locks only after eight returns have been received, at distances of 3.5 to 12 n miles (6.5 to 22 km), whereupon the seeker guidance system switches off the autopilot. A throw-off gyroscope takes the missile on target a few seconds before impact as it becomes too close for radar-generated homing signals. Russian Navy tacticians calculate that seven to eight missiles are required to destroy a cruiser-size target and four for a destroyer, making salvo firing a major feature of any tactical engagement scenario with SS-N-2c missiles to ensure destruction of the target.

Specifications

(SS-N-2c)
Length: 6.55 m (21.5 ft)
Diameter: 76 cm (30 in)
Wing span: 2.4 m (7.87 ft)
Speed: Mach 0.9
Weight (without booster): 2,500 kg (5,511 lb)
Warhead: 454 kg (1,000 lb) hollow-charge
Fuzes: Impact, proximity
Range: 3-46 n miles (5.5-85 km)
Guidance: Autopilot with active radar (supplemented in some with IR)

MS-2 seeker
Frequency: I-band (8-12 GHz) (four presets)
PRF: 300-500 pps (adjustable)
Altitude control: Barometric pressure device

Manufacturer/Contractor

Raduga, Moscow, Russia.

SURFACE-TO-AIR MISSILES (SAM)

M-1 Volnya-M (NATO = SA-N-1B 'Goa' Mod 1) air defence system

Warszawa is armed with two ZIF-101 twin-arm, stabilised, launchers each with a magazine for 16 RZ-61 missiles (SA-N-1). SA-N-1 is a naval version of the Soviet army's SA-3 and is a command-guided missile with a speed of Mach 3. The missiles are loaded hydraulically with the launch rails in a vertical position and on launch the booster burns for up to 2.6 seconds before being jettisoned, while the sustainer burns for 19 seconds. The fire-control computer receives data from the 'Peel Group' radars as it tracks both target and missile and continually generates missile guidance commands, which are communicated through a B-band (250 MHz to 0.5 GHz) UHF uplink. The warhead is armed after the missile has travelled 50 m, while the proximity fuze is activated by a command signal when the missile is 300 m from the launcher. If the missile fails to intercept, a further signal is sent either to change the trajectory or to self-destruct. SA-N-1 has a secondary anti-ship capability, with an effective range bracket of 4 to 9 n miles.

Specifications

Length: 6.1 m (20 ft)
Diameter:
missile: 37 cm (14.56 in)
booster: 55 cm (21.7 in)
Wing span: 1.2 m (3.94 ft)
Weight: 946-950 kg (2,086-2,094 lb)
Speed: Mach 3.5
Range: 1.33-16 n miles (2.5-30 km)
Guidance: Radar command
Warhead: 60 kg (132 lb) HE fragmentation warhead
Fuzes: Contact and radar proximity

Manufacturer/Contractor

Fakel.

Russian destroyer Smely *(D 165) while in Russian service. It was built as a standard Kashin, but converted to Kashin Mod in the mid-1970s to the standard seen here (in 1981). It was then substantially refitted prior to transfer to the Polish Navy* (H & L van Ginderen Collection)

TORPEDOES

There is one PTA-53-61, five-tube 533 mm (21 in) torpedo launcher for SET-53M torpedoes.

GUNS

Two AK-726 twin 76 mm (3 in)/59 mountings

There are two twin AK-726 turrets, one at either end of the ship. The AK-726 is a multirole weapon system designed for air defence, surface engagement and shore bombardment roles and consists of two 76 mm guns mounted in a turret with a 5 mm metal shield. Each gun has its own loading system based upon a continuous supply of ammunition from an intermediate magazine on a below-decks platform under the turret, where ammunition from the main magazine is manually inserted into separate hoists, which carry the rounds into the turret and onto a feeder rail. As the gun recoils the next round is brought forward for insertion into the breech and as it counter-recoils a new round is brought in position for insertion in the next cycle. The whole mounting can contain 60 rounds of which two are on the feeder rail and four are on the hoists at any one time.

The prime ammunition is the UOFB-62, a fixed round which weighs 12.8 kg (28.2 lb). The projectile weighs 4.6 kg (10.1 lb) and has 400 g (14 oz) of A-IX-2 explosive and a VG-67 point impact fuze. A total of 280 rounds is carried.

There is a five-man crew in the turret: the gun captain, two layers and two loaders. There is a further team of four loaders in the below-decks magazine.

AK-726 is associated with 'Owl Screech' radar. In addition to radar fire control there is local control through the Prisma optical sighting system, which may be used for engaging targets with speeds of up to 600 m/s (Mach 1.75).

Specifications

Calibre: 76 mm
Length of barrel: 59 calibres
Muzzle velocity: 980 m/s (3,215 ft/s)
Traverse: 360° at 36°/s
Elevation: −7 to +85° at 32°/s
Ammunition (total): 16 kg (35.3 lb)
Rate of fire: 90 rds/min (whole mounting)
Range:
anti-surface: 8 n miles (15 km)
anti-air (max): 10,000 m (32,810 ft)
anti-air (effective): 7,000 m (22,967 ft)

30 mm/65 AK 630M Gatling-type close in weapons system

There are four 30 mm/65 calibre AK-630 Gatling close in weapon systems, which are all located in the waist, grouped around the foot of the tower supporting the after 'Peel Group' director. These have five roles, engaging anti-ship missiles, aircraft, small surface vessels, drifting mines and unprotected targets ashore. The AO-18 weapon is a water-cooled, six-barrelled, Gatling-principle weapon with fixed breech block and revolving barrels. The weapon is believed to operate in a similar manner to that of the Phalanx, firing bursts of up to 400 rounds, but unlike the US weapon AK-630 features a separate radar director (Drum Tilt)

Specifications

Calibre: 30 mm
Length of barrel: 65 calibres
Number of barrels: 6
Muzzle velocity: 890 m/s (2,920 ft/s)
Cooling: Water
Traverse: 360° at 70°/s
Elevation: −12 to +88° at 50°/s
Crew: 1 (off mount)
Range: 4,000 m (13,123 ft) (radar fire control), 5,000 m (16,400 ft) (electro-optic fire control)
Rate of fire: 4,000-5,000 rds/min
Magazine: 2,000 rds
Weight of complete round: 1.224 kg (2.69 lb)
Ammunition types: UOF-84 HE-I weight 384 g (13.54 oz); UOR-84 HE-T weight 388 g (13.68 oz)
Fuze: MG-32 point impact (both rounds)

Saluting gun: 2—40 mm saluting guns

ANTI-SUBMARINE MORTARS

RBU-6000

Two sets of 12-tube RBU-6000s are mounted on the roof of a deckhouse immediately forward of the bridge. The mounting can traverse through 360° and elevation limits are −15° to +60°. Loading is automatic from a below-deck magazine. It is estimated that the rockets weigh 110 kg, with a 25 kg warhead. Pairs of tubes are fired in sequence. The RGB-60 rocket is fitted with an impact-time fuze, which detonates either on hitting a solid object (such as a submarine) or reaches a preset depth. Firing is usually conducted in a full salvo of 12 rockets, but it is also possible to fire single rockets, or four- or eight-rocket salvos, if the tactical situation requires it. The warhead weighs 31 kg. A total of 120 rockets is carried.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES ESM/ECM

Bell Shroud

There are two Bell Shroud ESM antennas at the foot of the foremast. This is basically a Watch Dog B system with two extra pairs of receive antennas to cover higher frequencies in the radar spectrum. Bell Shroud is the standard intercept system used on destroyers and frigates of the Russian Navy, and is used in conjunction with Bell Squat as the standard intercept/jamming system.

Bell Squat

There are two Bell Squat antennas. This equipment was derived from Top Hat with the frequency bands increased to cover K-band. Two types of ECM system are in use, Bell Squat A which uses barrage jamming, and Bell Squat B which employs deception jamming.

DECOYS

Decoys include four 16-tubed chaff launchers and two towed torpedo decoys.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS AND DATALINKS

IFF: Salt Pot
Satellite navigations system: Cykada.

WEAPONS CONTROL

Tee Plinth optronic directors

There are two Tee Plinth optronic directors. These are television monitors, with the camera under an armoured protective helmet to enable the officers in the combat information centre to observe what is going on.

Tilt Pot optronic directors

Four Tilt Pot fixed TV monitors.

RADARS

Head Net C air surveillance radar

Head Net C (MR-310 Angara) is an E-band, 3D radar, whose primary use is as height-finder for the SA-N-1 missile system. It is mounted at the head of the fore-mast and consists of two back-to-back Head Net A scanners, with one of the scanners tilted at some 30° to the horizontal. This displaces the resulting fan-shaped elevation beam by the same amount from the vertical, which, in combination with the vertical beam produced by the companion scanner, provides the means for height-finding using the 'V-beam' technique. The two beams are also separated in azimuth by 180°. In practice, the vertical beam fulfils the search function and the operator selects a target for which height data is

Flagship of the Polish Fleet, Warszawa *was leased from Russia in 1988 and purchased outright in 1993. The ship uses Russian systems except for three radars, which are of Polish design and manufacture. These are the SRN-207 (behind Head Net C antenna) and two SRN-7453 (one above the other at the side of the foremast)* (Jane's/H M Steele)

required, and by placing a marker on this target (or similar technique) a range gate is placed in the second (inclined) beam and excludes other targets. Computation to give a height readout can then be performed by analogue or digital methods. Maximum range is of the order of 70 n miles (128 km).

Big Net long-range 3D air surveillance radar

Big Net is mounted on top of the main mast in both Kashin and Kashin Mod. It is a very large, long-range air surveillance radar operating in D/E band. Beamwidth is 5° and scan rate between 6 and 8 rpm. The open lattice reflector is of elliptical parabolic form, illuminated by an underslung horn feed carried on a solid boom, and with two balance vanes behind it. Range performance is estimated as more than 100 n miles (185 km) against an aircraft at medium altitude, and up to 200 n miles (370 km) at higher altitudes.

Navigation radars

Warszawa carries three Polish navigation radars: two SRN 7453 Nogat and one SRN 207. These operate in the I band (between 9,400 and 9,600 MHz)

Peel Group

Peel Group (Jatagan) is the H/I-band (6 to 10 GHz) monopulse fire-control radar for the SA-N-1 SAM system. It features two pairs of solid reflectors, one large and one small, with one pair in the vertical plane and the other in the horizontal plane. They are grouped around a prominent conical lattice antenna which is believed to be for command guidance signals and together they probably provide tracking in three co-ordinates. The larger antennas may be for long-range target acquisition and 'coarse' tracking while the smaller ones probably provide precision tracking at closer ranges. The practical range of this system is believed to be 8 to 11 n miles (15 to 20 km) with one target engaged per launcher although two missiles may be launched at each target.

Owl Screech gunfire control radar

There are two Owl Screech (MR-105 Turel) gunfire control directors for the AK-726 76 mm guns. Owl Screech is a fire-control radar of conventional design, widely used in many classes of vessels, distinguished by a circular dish scanner, behind which is mounted a fairly bulky housing which is assumed to contain transmitter and receiver, and probably turning and stabilisation gear. The complete radar is pedestal mounted. The 2.3 m (7.5 ft) diameter scanner has a central feed supported by a four-leg structure. Feed arrangements could incorporate a rotating dipole to provide a conical scan search pattern. Dish diameter is approximately 2 m (6.5 ft) and the operating frequency is in the H/I-band.

The NATO designation Owl Screech is derived from signal characteristics noted in the course of ELINT monitoring.

The principal function is that of gunfire director against aircraft targets, although this type probably also has a certain capability against surface targets, and possibly splash detection.

Bass Tilt

Bass Tilt (MR-123) is an H-band system with its director mounted on a pedestal and its antenna with a drum-shaped radome 1.2 m (3.9 ft) in diameter inclined at an angle of approximately 45°. The director is 2 m (6.5 ft) high and 1.45 m (4.75 ft) long. The radar is probably linked to a ballistic computer and each director controls up to two AK-630 gun mountings. In addition to the radar there is a fall-back optical and/or electro-optical control system, the latter possibly based upon the sensor with the NATO codename 'Tee Plinth'.

SONARS

MGK-335 Platina sonar suite

According to recent information, *Warszawa* is fitted with a sonar suite named MGK-335 Platina, which consists of two principal elements: a bow-mounted sonar (NATO = Bull Horn) and a variable depth sonar known as Hosta (Mare Tail).

AVIATION

AVIATION FACILITIES

The aviation facilities are the same as those for Kashin Mod; that is, a raised flight deck at the stern

Specifications

Flight deck: 20 × 15.8 m (66 × 51.8 ft)

HELICOPTERS

PZL W-3UI Alligator

The Polish Navy has used the Mil Mi-14 Haze for some years, but is developing an ASW version of the PZL W-3 Sokol for use aboard the *Warszawa*. This aircraft, W-3UI Alligator, will be based on the W-3RM Anakonda, already in service for offshore search and rescue, which has a watertight cabin, six inflatable flotation bags, and an additional window in the lower part of each flight deck door.

Specifications

PZL W-3RM Anakonda
Main rotor diameter: 15.70 m (51.5 ft)
Tail rotor diameter: 3.03 m (9.95 ft)
Height to top of rotor head: 3.80 m (12.5 ft)
Basic operating weight empty: 3,850 kg (8,488 lb)
Max fuel weight: 1,326 kg (2,923 lb)
Max payload, internal or external: 2,100 kg (4,630 lb)
Normal take-off weight: 6,100 kg (13,448 lb)
Max take-off weight: 6,400 kg (14,110 lb)
Performance: (max take-off weight of 6,400 kg (14,110 lb) at 500 m (1,640 ft)
Max level speed: 124 kts (230 km/h)
Cruising speed at max continuous power: 118 kts (218 km/h)
Max rate of climb at S/L: 492 m (1,615 ft)/min
Service ceiling: 4,650 m (15,250 ft)
Hovering ceiling: IGE 2,500 m (8,200 ft)
Range, 30 min reserves:
standard fuel: 334 n miles (620 km)
Power plant: 2 WSK-PZL Rzeszow PZL-10W turboshafts, each with rating of 671 kW (900 shp) for take-off
Avionics: Standard IFR nav/com avionics for adverse weather operation by day or night; Chrom (NATO = 'Pin Head') IFF transponder; Bendix/King 5A-813 weather radar; stability augmentation system standard; AP Decca navigator; SPOR search and detection system; modified Syrena RWR in military versions.

PROPULSION

Specifications
System: Combined gas turbine and gas turbine (COGAG)
Main machinery: 4 DE 59 gas turbines (2 × DE-59P, 2 × DE-59L); 70.6 MW (96,000 hp (m))

Auxiliary power: 4 GTU-6A, 600 kW; 2 7D12, 200 kW
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The Polish Navy has traditionally operated a small number of destroyers and from the 1950s onwards these have all been of Soviet/Russian origin. Two 'Skory' class were operated from 1957/58 to 1975, and one 'Kotlin Sam II' class from 1970 to 1986. *Warszawa* was built as the Russian 'Kashin' class destroyer *Smely* and served in the Russian Navy from 1966 to 1987. It was taken in hand at St Petersburg and converted at the port of Oksywie prior to handing over to the Polish Navy on loan in 1988. The ship was purchased outright in 1993.

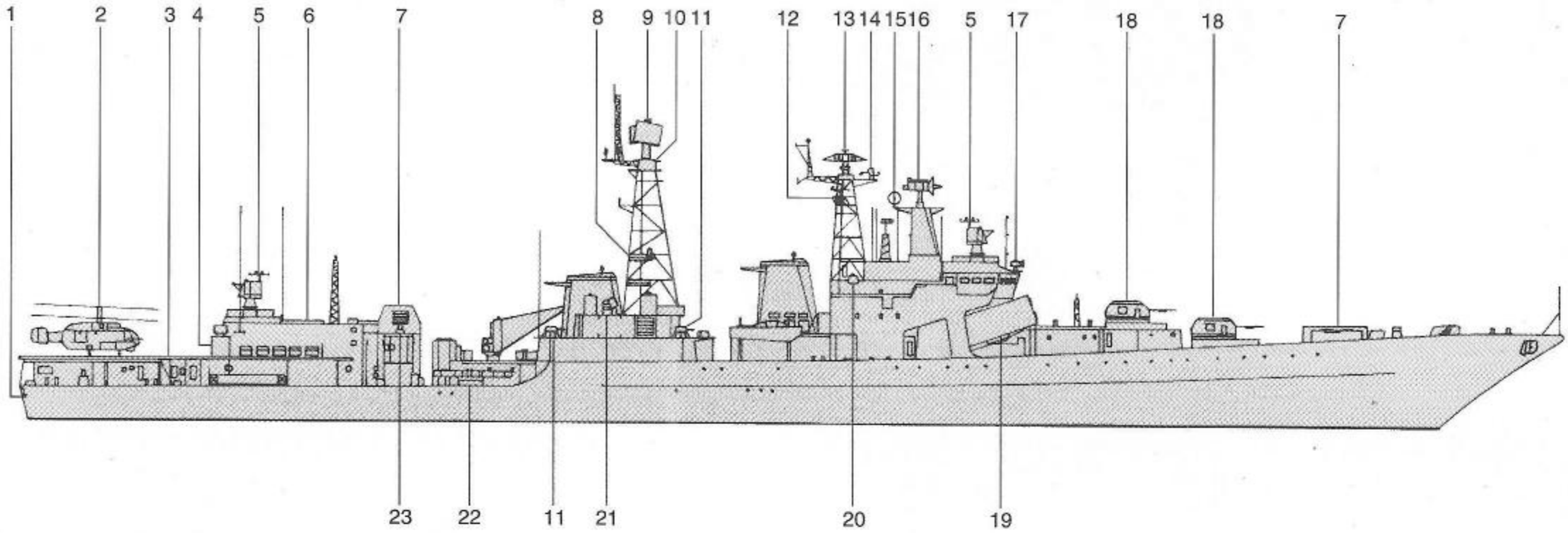
DESIGN

No changes were made to the armament before the transfer, except that Polish navigation radars were fitted.

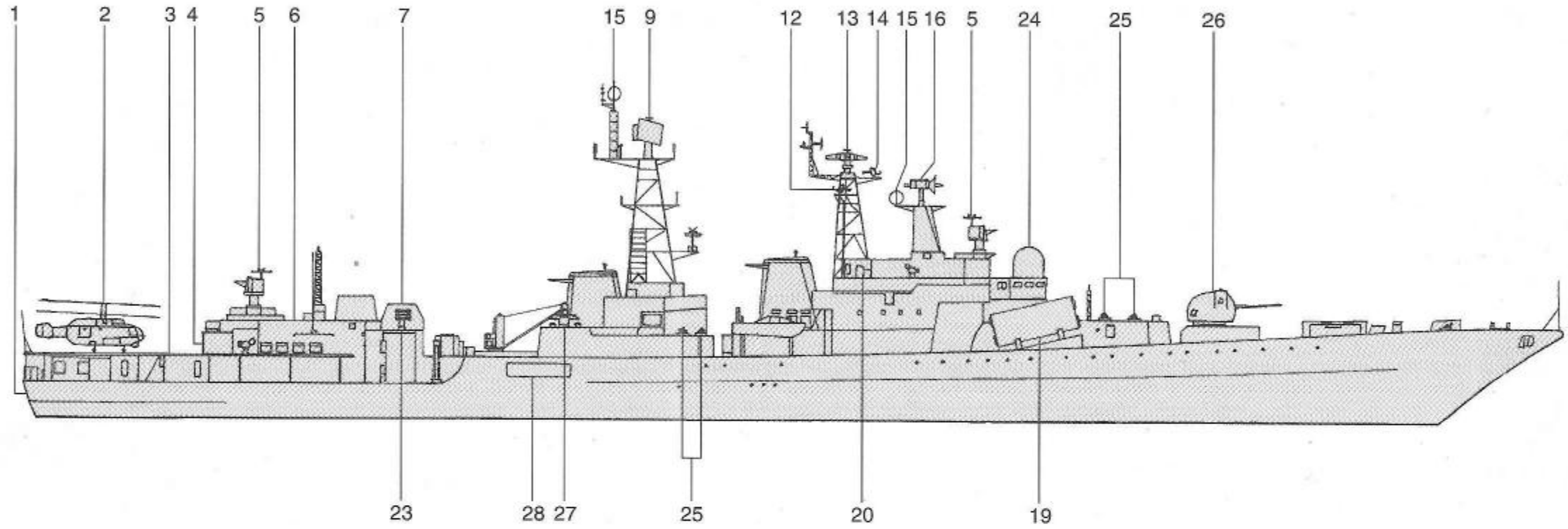
OPERATIONAL

Warszawa serves on the Third Flotilla at Gdynia and is also the flagship of the Polish Navy. The ship is expensive to maintain, but suggestions that it might be paid off seem unlikely in view of a mini-refit which took place in late 1994.

UDALOY



Admiral Spiridinov *(Udaloy I)* (Ian Sturton)



Admiral Chabanenko (Udaloy II) (Ian Sturton)

1 *Mare Tail VDS* **2** *Kamov Ka-27 ASW helicopter* **3** *Flight deck* **4** *Fly Screen B (starboard side only)* **5** *Cross Sword fire control (for SA-N-9)* **6** *Hangar* **7** *SA-N-9 Gauntlet vertical launcher* **8** *Wine Glass jammer* **9** *Top Plate radar (air search) (not* Udaloy, Kulakov) **10** *Round House TACAN (two)* **11** *AK-630 Gatling CIWS* **12** *Palm Frond radar (navigation) (one)* **13** *Strut Pair radar (air search)* **14** *Palm Frond radar (navigation) (one)* **15** *Cross Loop communications DF* **16** *Kite Screech fire control (100 mm guns)* **17** *Eye Bowl fire control (SS-N-14)* **18** *100 mm (3.9 in)/59 single automatic gun* **19** *SS-N-14 Silex quad launcher (two)* **20** *Bell Shroud ESM* **21** *Bass Tilt fire control (AK-630)* **22** *Four 533 mm (21 in) torpedo tubes (two sets)* **23** *RBU-6000 torpedo countermeasures system* **24** *Band Stand datalink (SS-N-22)* **25** *PK 10 chaff launcher* **26** *AK-130 130 mm/70 twin gun mounting* **27** *CADS-N-1 combined gun/missile (two)* **28** *533 mm (21 in) torpedo tubes (five per side behind hatch)*

GENERAL SPECIFICATIONS

Operator: Russia
Type: Type 1155/Type 1155.1
National designation: *bolshoy protivolodochny korabl* (large anti-submarine ship)

Class: UDALOY I (FREGAT)/UDALOY II

Built:
Udaloy I: 12
Udaloy II: 1
Active:
Udaloy I: 10 (see 'Current state')
Udaloy II: 1

Displacement
Udaloy I
standard: 6,840 t
full load: 8,200 t
Udaloy II
standard: 7,700 t
full load: 8,900 t

Dimensions
Length: 163.0 m (534.8 ft)
Beam: 19.0 m (62.33 ft)
Draught:
hull: 5 m (16.4 ft)
sonar: 7.8 m (25.6 ft)

Speed:
max: 29.5 kts
cruising: 14 kts
Range: 2,600 n miles at 30 kts; 4,000 n miles at 18 kts

Complement:
Udaloy I: 249 (29 officers)
Udaloy II: 250 (29 officers)

SHIPS

Udaloy I

UDALOY
Builder Yantar, Kaliningrad 820, Russia
Laid down 1977
Launched Feb 1980
Commissioned Nov 1980

VITSE-ADMIRAL KULAKOV
Builder Zhdanov Yard, St Petersburg, Russia
Laid down 1977
Launched Apr 1980
Commissioned Sep 1981

MARSHAL VASILEVSKY
Builder Yantar, Kaliningrad 820, Russia
Laid down 1979
Launched: Jan 1982
Commissioned Jun 1983

ADMIRAL SPIRIDONOV
Builder Yantar, Kaliningrad 820, Russia
Laid down 1980
Launched Nov 1983
Commissioned Sep 1984

MARSHAL SHAPOSHNIKOV
Builder Yantar, Kaliningrad 820, Russia
Laid down 1982
Launched Jan 1985
Commissioned Oct 1985

SEVEROMORSK
Builder Yantar, Kaliningrad 820, Russia
Laid down 1982

An Udaloy at anchor in a Russian naval base

Launched Feb 1985
Commissioned Dec 1986

ADMIRAL LEVCHENKO
Builder: Zhdanov Yard, St Petersburg, Russia
Laid down 1982
Launched Mar 1985
Commissioned Jan 1988

ADMIRAL VINOGRADOV
Builder Yantar, Kaliningrad 820, Russia
Laid down 1985
Launched Jun 1987
Commissioned Oct 1988

ADMIRAL KHARLAMOV
Builder Yantar, Kaliningrad 820, Russia
Laid down 1985
Launched Jun 1988
Commissioned Sep 1989

ADMIRAL PANTELEYEV
Builder Yantar, Kaliningrad 820, Russia
Laid down 1987
Launched Feb 1990
Commissioned Jul 1991

Udaloy II

ADMIRAL CHABANENKO
Builder Yantar, Kaliningrad 820, Russia
Laid down 1989
Launched 12 Dec 1992
Commissioned 13 Sep 1995

WEAPONS SYSTEMS

ANTI-SHIP MISSILES

P-270 Moskit (NATO = SS-N-22 'Sunburn') medium-range anti-ship missiles

(Udaloy II only.) In the Udaloy II the eight angled launcher-containers either side of the bridge contain SS-N-22 anti-ship missiles and not anti-submarine missiles as in Udaloy I. SS-N-22 is a ramjet-powered Mach 2 missile system designed to reach the target so fast that the enemy, even if using Aegis-equipped ships with Standard SM-2 missiles, will have insufficient time in which to react. The missile has four clipped-delta wings and four smaller tail surfaces of similar shape, all of which are folded when the missile is in the launcher. The launch tubes are inclined at an angle of 15° and there are no reloads. The fire-control system is based on the strut Pair/Top Steer combination, which has an air and surface search function, as well as a secondary tracking function for anti-ship missiles. The fire-control system may also receive data from the Big Bulge I/J-band radars carried by Ka-27 'Helix B' helicopters for Over-The-Horizon (OTH) targeting.

An engagement starts with data on the location of both launcher and target being fed into the missile from the fire-control system, following which the doors at the front and at the rear of the launcher cell open and the booster ignites. The missile may be launched to engage targets in a 120° arc based upon the ship's course. Once clear of the launcher, wings and tail surfaces deploy and the missile briefly rises, before dropping to its cruising altitude of 20 m, by which time the ramjet is operating. The active radar seeker then searches for the target and homes upon it when 'lock on' is achieved. In the event of jamming, the seeker has a home-on-jam capability.

At a speed of Mach 2, the missile takes 2 minutes to cover its full range and the manufacturer claims that 1 to 2 missiles could incapacitate a destroyer, while 1 to 5 missiles could sink a 20,000 tonne merchantman. An extended-range missile (3M80E) is now available with a range of 65 n miles (120 km).

Specifications

Length: 9.38 m (30.77 ft)
Diameter: 130 cm (51.2 in)
Wing span: n/k
Weight: 3,950 kg (8,708 lb)
Speed: Mach 2
Range:
3M80 missile: 48 n miles (90 km)
3M80E missile: 65 n miles (120 km)
Guidance: Inertial
Warhead: 300 kg semi-armour-piercing

Manufacturer/Contractor

Raduga, Russia.

Summary

Weapons system		Udaloy I	Udaloy II
Anti-ship	SS-N-22	—	8 (2 × IV)
Air defence	Klinok (SA-N-9)	8 (2 × IV)	8 (2 × IV)
ASW	SS-N-14 SS-N-15	8 —	— (see Note)
Guns	130 mm 100 mm AK-630 CADS-N-1	— 2 (2 × I) 4 —	2 (2 × II) — — 2
Torpedo tubes	533 mm	8 (2 × IV)	10 (2 × V)
ASW mortars	RBU-6000	2	2
Mines		30	—
Helicopters	Ka-27 Helix A	2	2

Note
SS-N-15 is launched from the 533 mm torpedo tubes and the number of weapons carried is not known.

SURFACE-TO-AIR MISSILES (SAM)

Altair Klinok air defence system

(Udaloy I and Udaloy II.) Both classes have two Klinok air defence systems, one forward, one aft. Each system consists of a group of four vertical short-range SAM launchers and either a battery of two AKG-630 Gatlings (Udaloy I), or four vertical missile launchers and a single CADS-N-1 combined gun and short-range missile launcher (Udaloy II). In addition, each Klinok includes an 8-round magazine; a command and control system; and a Cross Sword fire-control radar. The forward VLS complex is situated on the forecastle, with two pairs of tubes side-by-side, while the second complex is aft, with one pair of tubes across the ship and the second pair along the centreline, in a 'T'.

Klinok is intended for all-weather use against aircraft, missiles and small craft and is a modular system based on the 9M330 'Kynshal' missile (NATO = SA-N-9 Gauntlet). For launching, the allocated container is rotated into position below the hatch, whereupon the gas-ejection system forces the missile out of the cylinder, simultaneously deflecting the missile in the direction of

A stern view of Admiral Levchenko. *Note the jib of the crane, which is normally stowed in the gap between the two after stacks, and the torpedo tubes. One of the two RBU-600 ASW and anti-torpedo rocket launchers can be seen at the forward end of the after deckhouse. The large size of the door in the transom is also apparent, indicating that the VDS 'fish' must be of considerable size* (Jane's/H M Steele)

the target. Once the missile has reached a safe height of some 18 to 20 m above the deck the booster-sustainer comes into operation, accelerating the missile rapidly to its maximum speed. The computer-controlled fire-control system is highly automated and apparently uses one computer for the Cross Sword radar system and two to control the remainder of the Klinok system and to interface with other sensors.

The manufacturers state that up to four targets travelling at Mach 2 may be engaged simultaneously and that the system can operate up to eight missiles simultaneously. The system can be available in 15 seconds when on alert or 3 minutes from 'cold start' and the response time is 8 to 24 seconds depending upon the search radar's mode of operation.

Specifications

SA-N-9 missiles
Length: 3.5 m (11.5 ft)
Diameter: 23.5 cm (9.25 in)
Wing span: 75 cm (29.5 in)
Weight: 165 kg (364 lb)
Warhead: 15 kg (33 lb)
Speed: Mach 2.5
Range: 0.5-6.5 n miles (1.5-12 km)
Altitude: 10-6,000 m (33-20,000 ft)

Klinok system
Max target speed: 700 m/s (2,300 ft/s)
Max number of simultaneous targets: 4
Max number of missiles guided simultaneously: 8
Guidance: Command guidance
Target detection range: 24.4 n miles (45 km)
Target killing range:
missiles: 0.8-6.5 n miles (1.5-12 km)
guns: 0.1-6.5 n miles (0.2-12 km)
Response time: 0-24 s
Fuze: pulse radio

Manufacturers/Contractors

Altair Research and Development Corporation, Russia (system).
Fakel Experimental Design Bureau, Kaliningrad, Russia (missile).

ANTI-SUBMARINE MISSILES

SS-N-14 'Silex' long-range anti-submarine torpedo delivery system

(Udaloy I only.) Eight SS-N-14 ('Silex') missiles are mounted in two large quad launch-bins either side of the bridge. SS-N-14 is a long-range torpedo delivery system capable of operating to beyond the First Convergence Zone. The missile is powered by a solid propellant booster-sustainer and is reported to have an autopilot which can be updated in flight. Payload is a Type 53-72 torpedo, which is faired into the underside of the airframe. The ASW version of the weapon requires only 15 seconds warm-up time and cruises at a height of some 750 m (2,461 ft), being guided towards the approximate location of the target by radio command. The torpedo is ejected immediately above the submarine's estimated position and deploys its parachute which slows the descent. On entering the water the parachute is disconnected and the weapon begins a search pattern to acquire the target.

The missile body includes a 500 kg (1,102.5 kg) warhead, enabling the weapon to be used in an anti-ship role against targets up to 19 n miles (35 km) distant.

The target is initially located by sonar and the Eye Bowl F-band fire-control radar is used to guide and track the missile during flight.

Specifications

SS-N-14
Length: 7.2 m (23.62 ft)
Diameter: 0.574 m (1.88 ft), 1.35 m (4,43 ft) with torpedo
Launch weight: 4,000 kg (8,818 lb)
Range (anti-submarine): 30 n miles (55 km)
Speed: Mach 0.95
Guidance: Autopilot and command update

AT-2 (NATO = Type 53-72)
Range: 3,800 m (12,464 ft)
Max depth: 400 m (1,312 ft)
Homing:
Warhead: 100 kg (220 lb)
Speed: 40 kts
Length: 7.2 m (23.5 ft)
Diameter: 533 mm (21 in)

SS-N-15 (NATO = Starfish)

(Udaloy II only.) SS-N-15 (Starfish) long-range anti-submarine weapon system is similar in shape to SUBROC, having a long, slim cylinder with small, retractable fins and a booster rocket at the end. The weapon is

Admiral Levchenko *enters the British Portsmouth Naval Base, 27 April 1996. This ship appears to be carrying what is now the definitive weapons outfit and sensor suite* (Jane's/H M Steele)

loaded into a standard 533 mm (21 in) torpedo tube and is then launched in the same way as a torpedo, with the weapon travelling horizontally until it has cleared the ship's side when the rocket motor ignites and propels it upwards, where it flies to the target area and ejects the payload which descends to the sea retarded by a parachute. On entering the water, the weapon is automatically activated and begins carrying out a search and track pattern. The SS-N-15 payload is either a 200 kT nuclear depth charge or a Type 40 lightweight torpedo although it should be noted that, under current international agreements, nuclear warheads would not be carried at sea; the capability, however, remains.

Specifications
Length: 6.5 m (21.33 ft)
Diameter: 533 mm (21 in)
Wing span: n/k
Weight: 1,800 kg (3,968 lb)
Range: 24-27 n miles (45-50 km)
Speed: n/k
Guidance: Inertial

TORPEDOES

Udaloy I
There are two sets of quadruple 533 mm (21 in) torpedo tubes on a swivelling mounting in the waist. They launch the normal range of Russian torpedoes. There are no reloads.

Udaloy II
The torpedo tube arrangement in the Udaloy II is quite different, with two sets of five tubes each which are fixed and behind shutters, as in the latest US installations. The tubes are used to launch both conventional torpedoes and SS-N-15 Sunfish missiles, and it seems possible that there may be a central magazine.

GUNS

AK-130 130 mm/70 calibre twin
(Udaloy II only.) There is one twin 130 mm mounting on the foredeck. This mounting features two water-cooled 9.1 m (30 ft) long barrels of monobloc construction which fit into sleeves which are part of a common cradle, but with separate recoil cylinders under each gun. Unlike most similar Soviet weapons the elevating mass is close to the front of the turret. The steel turret is dome-shaped and sits on a 1.5 m (5.0 ft) high cylindrical steel base, which is believed to penetrate the deck to a depth of about 7 m (23 ft). The turret features an electro-optic sensor on the right of the elevating mass at the front and also contains an automatic loading system; it seems likely that the mounting will carry 80-90 rounds.

The L/70 fire-control radar is 'Kite Screech,' a G/I-band radar incorporating monopulse tracking, and it is likely that the radar compartment for this sensor also acts as the fire-control centre.

Specifications
Calibre: 130 mm (5 in)
Length of barrel: 70 calibres
Muzzle velocity: 950 m/s (3,117 ft/s)
Traverse: 360°
Elevation: −15 to +85°
Ammunition: 27 kg (59.5 lb)
Rate of fire: 80 rds/min (per mounting)
Range, anti-surface: 16 n miles (29.5 km)

AK-100 100 mm/59 medium calibre dual-purpose gun
(Udaloy I only.) There are two single AK-100 100 mm/59 calibre water-cooled mountings in enclosed turrets on the foredeck ('A' and 'B' positions).

Specifications
Calibre: 100 mm (3.9 in)
Length of barrel: 59 calibres
Muzzle velocity: 880 m/s (2,887 ft/s)
Traverse: 200° at 30°/s
Elevation: −10 to +85° at 20°/s
Weight of projectile: 15.6 kg (34.4 lb)
Rate of fire: 60 rds/min
Range, anti-surface: 21.5 km

30 mm AK-630 close in weapon system
(Udaloy I only.) There are four AK-630 close in weapon system (CIWS) turrets, which, instead of being split fore and aft as is the case in most Russian surface warships, are grouped in two close pairs either side of the after stack and mainmast. This multibarrel, high volume of fire gun system, has a separate fire-control radar and a below-deck control station with remote optical and/or electro-optical sensor. It fires five types of fire mission: against anti-ship missiles, aircraft, small surface vessels, drifting mines, and unprotected shore targets. The weapon consists of six water-cooled barrels, using the Gatling-principle with a fixed breech block and revolving barrels. The magazine contains 2,000 rounds of HE-I and HE-T ammunition. The gun fires bursts of up to 400 rounds, during which both the barrel and the breech block are cooled, with used cartridges and links being ejected into a bin below the elevating mass. The mounting is unusual in having an ignition system for burning off gun gases accumulating within it during firing.

Specifications
Calibre: 30 mm
Length of barrel: 65 calibres
Muzzle velocity: 890 m/s (2,920 ft/s)
Traverse: 360° (depending on location of turret) at 70°/s
Elevation: −12 to +88° at 50°/s
Crew: 1 (off mount)
Range:
radar fire control: 4,000 m (4,400 yd)
electro-optic fire control: 5,000 m (5,470 yd)
Rate of fire: 4,000-5,000 rds/min
Ammunition:
round: 1.224 kg (2.7 lb)
projectile weight: UOF-84 384 g (13.68 oz); UOR-84: 388 g (13.69 oz)

CADS-N-1 (Kashtan/Kortika) close in weapon system
(Udaloy II only.) The Kashtan combined missile/gun system is designed for defence against anti-ship missiles and guided bombs to distances up to 2 n miles (4 km). It consists of an above-deck combat module and a below-deck command module. The combat module is on a deck mounting on which it can turn 360° in azimuth. On either side of the module is a 2A38M 30 mm calibre water-cooled gun, capable of elevation only, and above it are four launcher-containers for 9M311 (NATO = SA-N-11) surface-to-air missiles. These are two-stage, solid propellant missiles with a 'fragmentation/multiple rod type' warhead and a proximity fuze, activated when the missile is within 5 m (16.4 ft) of the target.

The sensor is the 'Hot Flash' radar which features two paraboloid antennas with front horn feeds. The central one is probably a search radar, to detect and track sea-skimming missiles, while the one mounted to the right of it is probably the missile guidance radar. The transmitter and receiver electronics are mounted behind the antennas. To the left of the central radar antenna are two electro-optic sensors which are probably a laser rangefinder and a remotely operated TV camera.

Targets are designated through the ship's prime air search radar and the target is acquired through the search radar and, at ranges of 1,500 (4,921 ft) to 8,000 m (26,248 ft) it will be engaged with missiles using radar or TV tracking, with the missiles probably launched in pairs for increased kill probability. Guns will engage targets at closer ranges down to 500 m (1,640 ft). According to Russian publicity material the highly automated system can engage up to six targets per minute.

Russian sources state the 2S6M can engage targets flying at a maximum speed of 500 m/s (1,640 ft/s) with the complete system having a reaction time of eight seconds and a similar performance may be expected from the Kashtan.

Specifications
SA-N-11 missile
Length: 2.56 m (8.4 ft)
Diameter: 17 cm (6.7 in)
Wing span: n/k
Weight: 57 kg (126 lb)
Speed: Mach 2.6
Range: 4.5 n miles (8 km)
Guidance: Radar to command line of sight

Gun 2A38M gun
Length: 3.48 m (11.4 ft)
Weight: 223 kg (492 lb)
Cyclic rate of fire: 1,950-2,500 rds/min
Muzzle velocity: 960 m/s (3,150 ft/s)
Effective range: 2 n miles (4 km)
Effective altitude: 200-2,000 m (656-6,560 ft)
Magazines: 1,900 rds each

Manufacturers/Contractors
Ministry of Radio Industry, Moscow, Russia.
Scientific Production Corporation Phasotran, Russia.

ANTI-SUBMARINE MORTARS

RBU-6000
(Udaloy I/II.) There are two 12-tube RBU-6000 mortars located aft, either side of the SA-N-9 launcher. The mounting can traverse through 360° and elevation limits are −15° to +60°. Loading is automatic from a below-deck magazine. It is estimated that the rockets weigh 110 kg (242 lb), with a 25 kg (55 lb) warhead. Pairs of tubes are fired in sequence. The RGB-60 rocket is fitted with an impact-time fuze, which detonates either on hitting a solid object (such as a submarine) or reaches a preset depth. Firing is usually conducted in a full salvo of 12 rockets, but it is also possible to fire single rockets, or four- or eight-rocket salvos, if the tactical situation requires it. The warhead weighs 31 kg (68.4 ft).

MINES

(Udaloy I only.) There are launch rails for 30 mines, which are dropped over the stern. There are no mine facilities in Udaloy II.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

Wine Glass
(Udaloy I/II.) There are two Wine Glass jammers.

Foot Ball B
(Udaloy I only.) There are two Foot Ball B radomes, covering EW antenna arrays.

Bell Squat
(Udaloy I/II.) There are two Bell Squat ESM radomes, with the antennas in a small cylindrical radome, located on the outer end of the yard arm.

Bell Shroud
(Udaloy II only.) In Udaloy II the Foot Ball B is replaced by Bell Shroud, which is basically a Watch Dog B system with two extra pairs of receiver antennas to cover higher frequencies in the radar spectrum. Bell Shroud is the standard intercept system used on destroyers and frigates of the Russian Navy, and is used in conjunction with Bell Squat as the standard intercept/jamming system.

Half Cup
(Udaloy I/II.) There are six Half Cup laser intercept devices.

Admiral Levchenko. *The main mast. At the mast head is Top Plate with the dissimilar, canted arrays and an IFF interrogator above. The two large, white cylindrical radomes are Round House, providing a system similar to the Western TACAN. Just above the stacks are two Wine Glass jammers, while at the same level and forward is a Bell-series radome. On the deckhouse roof is a Bass Tilt radar director for the two AK-630 Gatling guns below it* (Jane's/H M Steele)

Cage Flask

(Udaloy I/II.) Cage Flask communications intercept aerials are mounted on the mainmast spur and on the mast on top of the hangar.

DECOYS

PK-10

(Udaloy I/II.) All Udaloys have the PK-10 naval decoy system, consisting of eight KT-216 launchers, a control console and munitions. The launcher unit has 10 120 mm barrels, set at an angle of about 45°. The launcher appears to be turnable. The control console appears to be a relatively simple design capable of controlling up to four launchers.

There are three types of munition, all for seduction purposes. SR-50 is a chaff round with a payload of 11 kg, SOM-50 is a heat-seeker/laser-guided missile seduction round with 7.3 kg payload, and SK-50 is a combined round with 9.1 kg payload.

Noise reduction system

Udaloy I is fitted with a noise reduction system similar in design and operation to the US Masker system. It is probable that Udaloy II has a similar system.

Foremast of an 'Udaloy' class destroyer. At the masthead is Top Plate, consisting of two dissimilar rectangular arrays back to back, with an IFF interrogator above. As viewed in this picture, the left-hand antenna is narrower, but deeper than that on the right, while the antennas are set at slightly different angles both horizontally and vertically. This results in a virtual 3D system which is relatively simple both electronically and mechanically. There are also three Palm Frond navigation radars on the yards and at the end of the left-hand yard a Bell Squat ESM dome. There is also a variety of wideband conical antennas, which appear to have a communications role (Jane's/H M Steele)

Admiral Levchenko. *The identifiable devices on the bridge roof are, from front to rear: two Eye Bowl radar directors for SS-N-14 missiles; Cross Sword director for SA-N-9; Kite Screech (atop small tower) fire director for the 100 mm guns; Quad Loop (at rear of Kite Screech platform), a communications DF device; the small tower between the two taller towers supports a small log-periodic communications antenna; the foremast is topped by Strut Pair, an air-search radar composed of two Strut Curve antennas back to back; also on the foremast are three Palm Frond navigation radars; two are on the cross-yard and are difficult to see, while the third stands out clearly; at the after end of the bridge wing (and directly below the foremast) is Bell Shroud, an ESM system* (Jane's/H M Steele)

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Bell Crown

(Udaloy I/II.) All ships have two Bell Crown datalinks. Bell Crown provides the datalink between the flagship of a group (master) and the subordinate units (slaves). Slaves use the system to pass sensor data to the master, which responds by passing commands to the units' Second Captain command system.

MP 145

(Udaloy I/II.) MP 145 is a radar and optronic system.

Round House

(Udaloy I/II.) All ships have two Round House Tactical Air Navigation (TACAN) radomes. Round House is invariably found in pairs, usually mounted on port and starboard yardarms on the main mast.

Salt Pot

(Udaloy I/II.) All ships have Salt Pot A and B interrogation friend-or-foe (IFF) antennas.

Fly Screen B

(Udaloy I/II.) All ships have Fly Screen B CCA (carrier-controlled approach)

Monolit

(Udaloy II only.) The Monolit system is used to target the SS-N-22 missile. The system consists of the Band Stand missile tracker and the Light Bulb which appears to function both as a datalink to the missile and also to over-the-horizon target acquisition/trackers, such as aircraft.

Bell Nest

(Udaloy II only.) Udaloy II also has Bell Nest datalink, purpose unknown.

RADARS

Summary

	Udaloy, *Kulakov*	Udaloy I Remainder	Udaloy II
Air search	2 × Strut Pair	Top Plate	Strut Pair Top Plate
Surface search/navigation	3 × Palm Frond	3 × Palm Frond	3 × Palm Frond
Fire control	2 × Eye Bowl (SS-N-14)	2 × Eye Bowl (SS-N-14)	
	2 × Cross Sword (SA-N-9)	2 × Cross Sword (SA-N-9)	2 × Cross Sword (SA-N-9)
	Kite Screech (100 mm guns)	Kite Screech (100 mm guns)	Kite Screech (130 mm guns)
	2 × Bass Tilt (30 mm guns)	2 × Bass Tilt (30 mm guns)	

SONARS

Horse Jaw

(Udaloy I.) Horse Jaw (Russian name: *Polinom*) is a relatively recent, hull-mounted, active search and attack sonar, operating at low and medium frequencies. It is installed in the 'Kirov' class battlecruisers, and the Udaloys are the only destroyers to mount this large array. It is normally found in conjunction with the SS-N-14 anti-submarine missile system.

Horse Tail

(Udaloy I/II.) Horse Tail is the variable depth sonar (VDS) normally associated with Horse Jaw. It is an active search sonar, operating at medium frequency, and is deployed through a large door in the transom.

New Sonar

(Udlaoy II.) A Russian line drawing of the Type 1155.1 Udaloy II shows a large bow sonar housing which includes not only the usual large dome at the foot of the stem, but also a long extension below the keel to a point immediately below the 130 mm mounting. There is a second, rectangular sonar window towards the rear of this housing, suggesting a sideways looking array. It is not clear whether the arrangements in the Udaloy I are the same.

AVIATION

AVIATION FACILITIES

Specifications

Flight deck:

Ustinov, Kulakov: 20 × 18 m (65.6 × 59 ft)

Remainder: 20 × 19.3 m (65.6 × 63 ft)

Hangar: There are two separate hangars, with the helicopters reaching the deck via an inclined ramp

HELICOPTERS

'Udaloy I' class ships carry two Ka-27 Helix A anti-submarine helicopters. With the change in emphasis in the Udaloy II from anti-submarine warfare and the installation of SS-N-22 anti-ship missiles, it seems possible that this ship might embark the Helix B over-the-horizon targeting version, but there has been no confirmation of this.

Kamov Ka-27PL (NATO = Helix A)

Specifications

Rotor diameter: 15.90 m (52.16 ft)
Rotor disc area: 397 m² (4,275 sq ft)
Fuselage length: 11.30 m (37.07 ft)
Height to rotor head: 5.40 m (17.72 ft)
Operating weight, empty: 6,500 kg (14,330 lb)
Max take-off weight: 12,600 kg (27,778 lb)
Max payload: 5,000 kg (11,023 lb)
Max level speed at optimum altitude: 135 kts (250 km/h)

An early view of an 'Udaloy' class destroyer. At that time there were two Strut Pairs at the mastheads (one was later replaced by Top Pair) and no Cross Swords were installed (note the empty platform above the helicopter control station) (UK MoD)

Endurance: 4.5 h
Engines: 2 Klimov (Isotov) TV3-117V turboshafts, each 1,645 kW (2,205 shp)
Accommodation: 3 (pilot plus 2)
Sensors: Surface search radar, sonobuoys, dipping sonar
Weapons: 2 torpedoes or 4 conventional depth bombs or mines

PROPULSION

Specifications

System: Combined gas turbine and gas turbine (COGAG)

Main machinery: 2 gas turbines; 40.8 MW (55,500 hp (m)); 2 gas turbines; 10 MW (13,600 hp (m))
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The 'Udaloy' class (Type 1165) was built as the successor to the 'Kresta II' class and although displacing 8,500 t (full load) the ships are generally classified as destroyers. The first of class joined the fleet in 1980 and was followed by eleven more until the last was commissioned in 1991. Two ships have already been stricken, both *Admiral Tributs* and *Admiral Ushakov* being badly damaged by (separate) fires in 1991 and deemed irrepairable.

A second group of ships was projected, of which one has been completed — see Udaloy II on next page.

DESIGN

The Udaloy was designed by the Northern Design Bureau, St Petersburg, under the leadership of Chief Designer V Mishin.

The ships are designed virtually exclusively for the anti-submarine mission with only short-range SA-N-9 SAMs for air defence and two single 100 mm guns for anti-ship fire missions. They were thus complementary to the 'Sovremenny' class, which was being produced at the same time.

The hull is large with a very long forecastle, with a sharply raked stem and the break well aft. There is a prominent knuckle with tumblehome above to deflect radar signals. Maximum beam is maintained to the stern to maximise the size of the flight deck. Extending, active roll dampers are fitted midships and there are large bilge keels. The effectiveness of all these measures can be gauged from reports that these ships have good sea-keeping properties and long endurance. Particular attention has been paid to habitability, with officers in single and double cabins, petty officers in two and four-berthed cabins, while sailors are 12 and 14 to a mess.

The gas-turbine (COGAG) propulsion plant is made as a single unit, driving the two shafts. The two cruise

engines can each drive both shafts, and the two boost engines can be cut in when required.

These were the first Soviet ships to have two helicopters with the two hangars set side by side, with inclined elevating ramps to the flight deck. They also have pre-wetting Nuclear, Biological, Chemical and Damage-control equipment and replenishment-at-sea (RAS) gear.

Initially the SA-N-9 system was not operational and the first three of the class commissioned without the Cross Sword fire-control radars. There also seemed to be a shortage of Strut Pair radars and the third to seventh hulls (both inclusive) initially had no air search radar on their foremasts on commissioning. These deficiencies have, however, been made good.

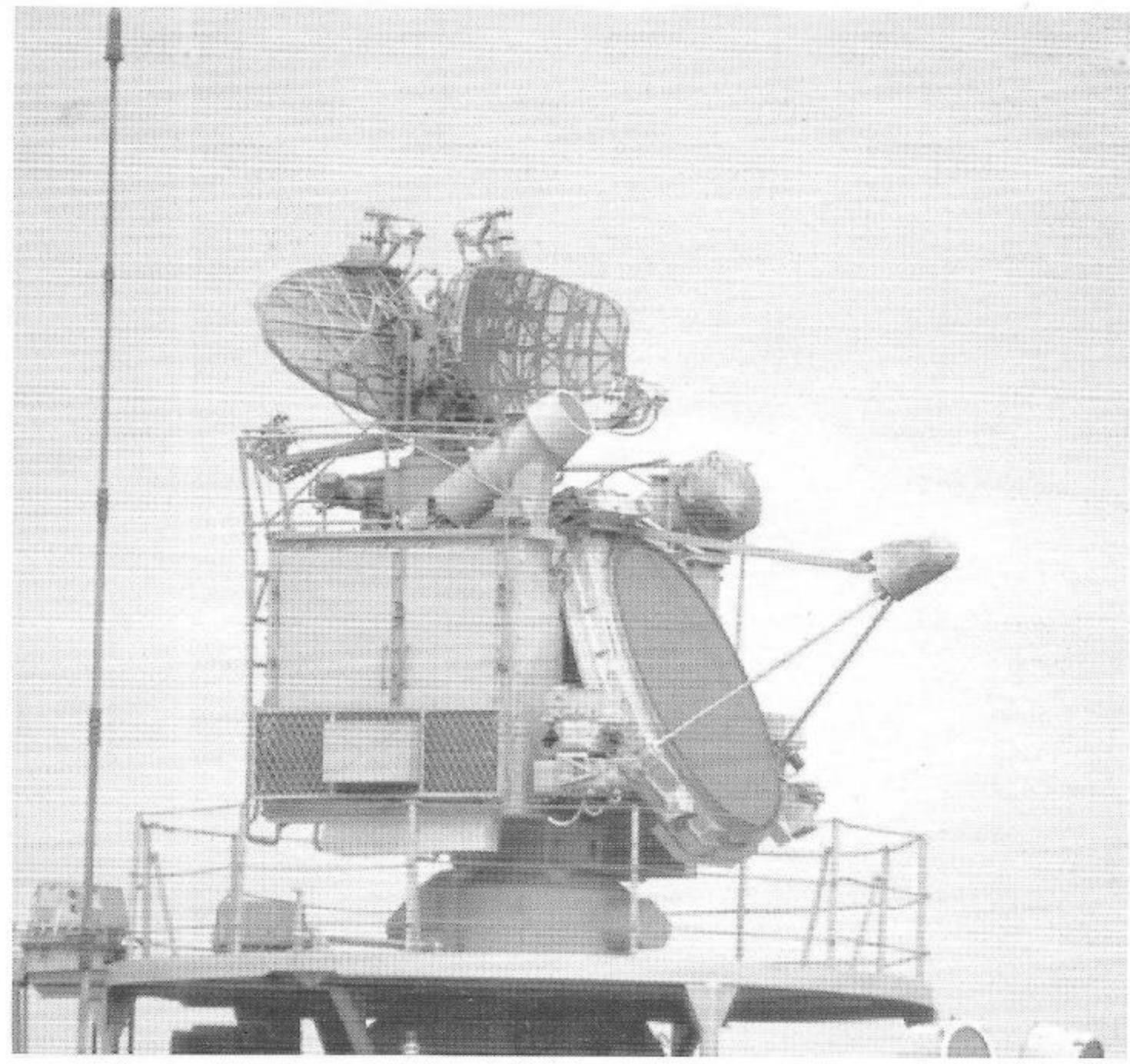
The chaff launchers are fitted on both sides of the foremast and inboard of the torpedo tubes. There are indications of a nuclear release mechanism, or interlock, on the lower tubes of the SS-N-14 launchers.

Udaloy II

Originally given the NATO designation Balcom 12, it was originally intended that there should be a class of at least three Udaloy IIs. The planned second in the class was laid down but later scrapped in an unfinished state in 1994, while the third was never even started. Udaloy II is a similar size to Udaloy I and has the same propulsion machinery, but has a different combination of weapon systems. Eight SS-N-22 anti-ship missiles replace the eight SS-N-14 anti-submarine missiles, although the reduction in ASW capability is made up by the inclusion of SS-N-15 Novator, which is launched from the conventional torpedo tubes. These tubes, for the first time in a Russian ship, are no longer on a rotating mounting on the weather deck, but have been moved inside the superstructure and protected from the elements by a hinged flap.

The twin single 100 mm guns have been replaced by a single twin 130 mm, and the close in AK-630 30 mm Gatlings have been removed and two CADS-N-1 installed in their place.

Short trials were carried out in late 1993, but sea trials did not commence until September 1995.



The after Cross Sword missile director in Admiral Levchenko. *On top of the director are two back to back search radars, with an IFF interrogator on top of each. The main antenna is optically flat with the illuminator set marginally off-centre. There are two co-axial antennas at 11 o'clock and 2 o'clock to the main antenna, one of which presumably is the command link, the other the missile tracker* (Jane's/H M Steele)

DEPLOYMENT

The most recent basing of the class was:

Northern Fleet — *Udaloy, Vasilevsky, Severomorsk, Kharlamov* and *Levchenko*

Pacific Fleet — *Spiridonov, Shaposhnikov, Panteleyev* and *Vinogradov.*

Current state

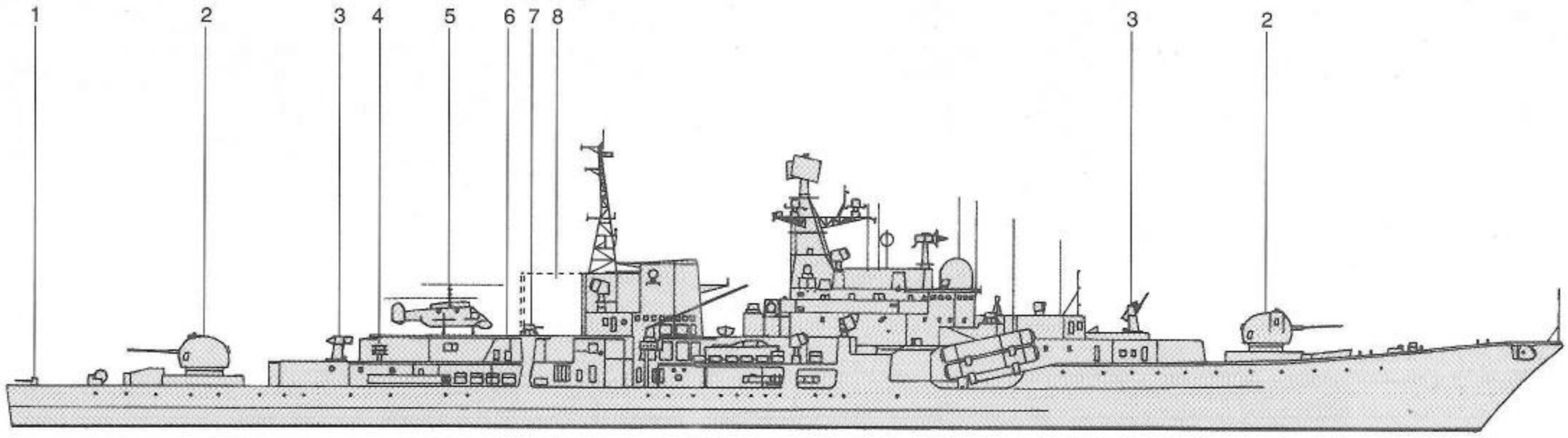
Of the 12 ships built two have already been paid off:

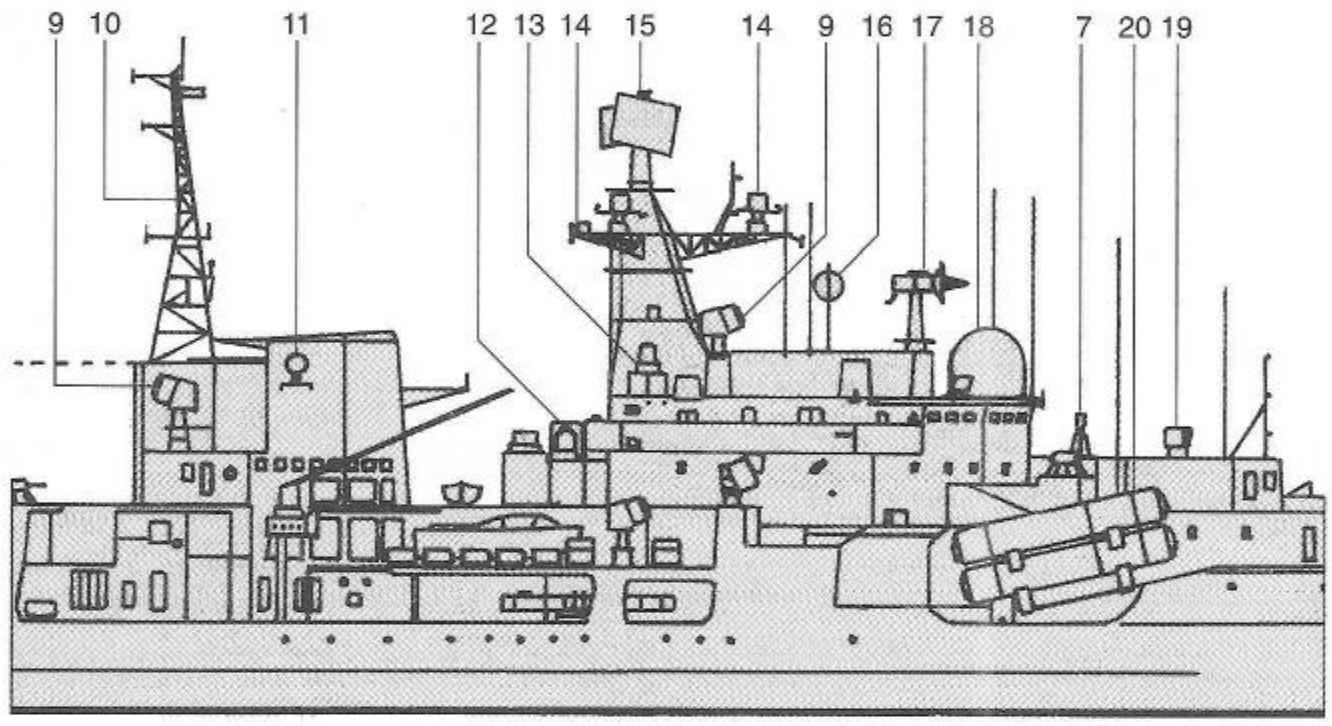
Admiral Zakharov, following a fire in March 1992.

Admiral Tributs after a machinery space fire in September 1995.

In addition, *Vitse Admiral Kulakov* was despatched from the Northern Fleet to the Baltic for repairs in 1992 and was moved to Kronstadt in 1994 without the work having being completed. Further, the first two ships in the class, *Udaloy* and *Marshal Vassilevsky* are reported to be 'probably non-operational'.

SOVREMENNY





Sovremenny (Ian Sturton)
1 *PK-2 chaff launcher (two)* **2** *AK-130 130 mm/70 twin automatic gun mounting* **3** *SA-N-7 (Gadfly) SAM launcher* **4** *RBU-1000 six-barrelled torpedo countermeasure launcher* **5** *Kamov Ka-25 or Ka-27 helicopter* **6** *Flight deck* **7** *AK-630 30 mm CIWS* **8** *Extendible hangar* **9** *Front Dome* **10** *Bell-series ESM antennas* **11** *Football jammer* **12** *Wine Glass jammer* **13** *Bell Shroud ESM* **14** *Palm Frond radar (navigation)* **15** *Top Plate radar (3D air search)* **16** *Cross Loop communications DF* **17** *Kite Screech fire control* **18** *Band Stand data link (SS-N-22)* **19** *Squeeze Box electro-optic director* **20** *SS-N-22 Sunburn SSM (eight launchers)*

GENERAL SPECIFICATIONS

Operator: Russia
Type: (Type 956/956A) (DDG)
National designation: *eskadrenniy minonosets* (destroyer)

Class: SOVREMENNY (SARVICH)

Active: 17
Building: 3

Displacement:
standard: 6,500 t
full load: 7,300 t

Dimensions
Length: 156 m (511.8 ft)
Beam: 17.3 m (56.8 ft)
Draught: 6.5 m (21.3 ft)

Speed: 32 kts
Range: 2,400 n miles at 32 kts; 6,500 n miles at 20 kts; 14,000 n miles at 14 kts

Complement: 296 (25 officers)

SHIPS

Type 956

SOVREMENNY
Builder Zhdanov Yard, St Petersburg, Russia
Laid down 1977
Launched Nov 1978
Commissioned 25 Dec 1980

OTLICHNNY
Builder Zhdanov Yard, St Petersburg, Russia
Laid down 1978
Launched Apr 1981
Commissioned 30 Sep 1983

OSMOTRITELNY
Builder Zhdanov Yard, St Petersburg, Russia
Laid down 1979
Launched Apr 1982
Commissioned Jun 1984

BEZUPRECHNY
Builder Zhdanov Yard, St Petersburg, Russia
Laid down 1980
Launched Aug 1983
Commissioned Jun 1985

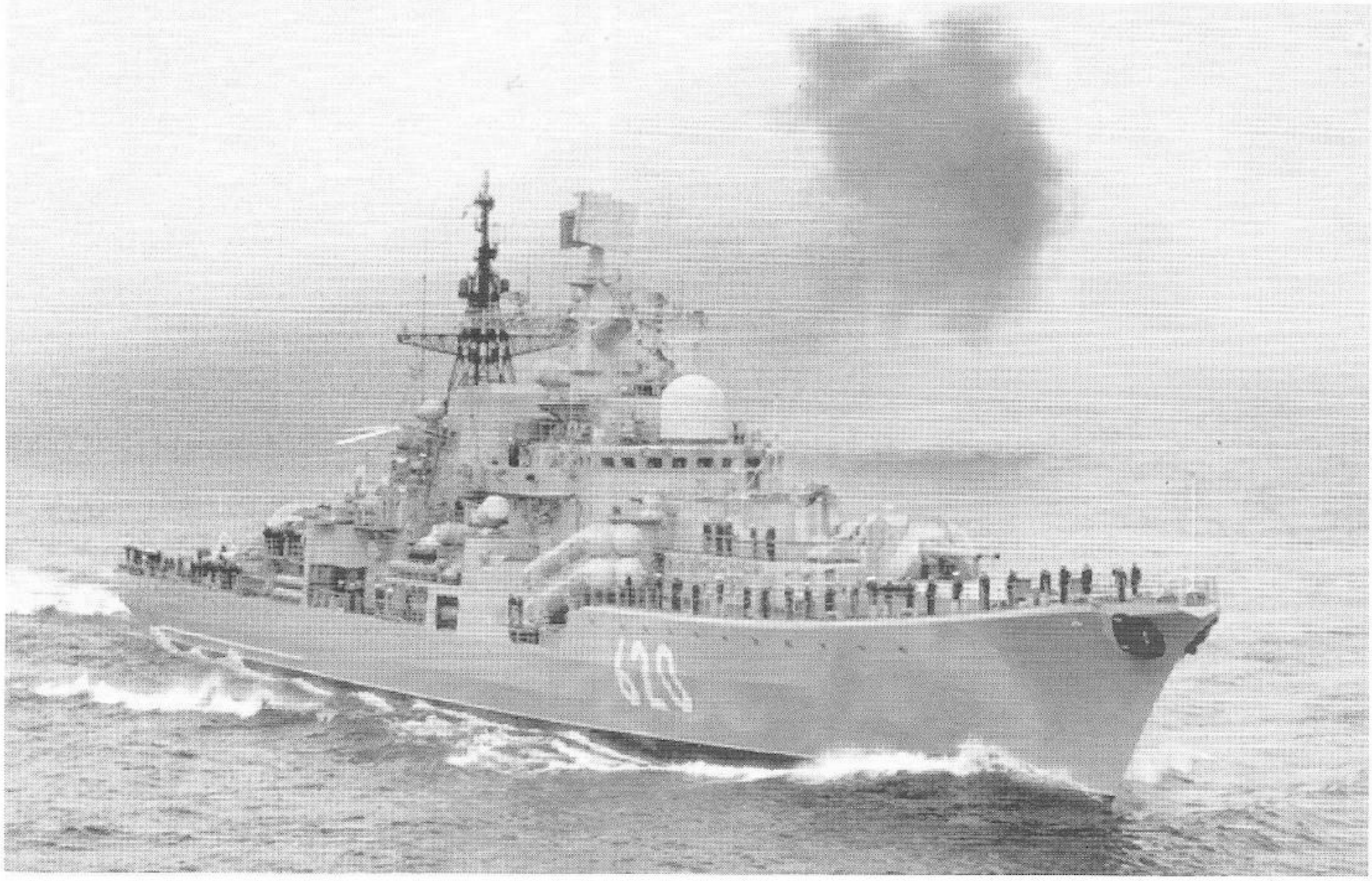
BOYEVOY
Builder Zhdanov Yard, St Petersburg, Russia
Laid down 1981
Launched Aug 1984
Commissioned Jun 1986

STOYKY
Builder Zhdanov Yard, St Petersburg, Russia
Laid down 1982
Launched Aug 1985
Commissioned Sep 1986

OKRYLENNY
Builder Zhdanov Yard, St Petersburg, Russia
Laid down 1983
Launched Jun 1986
Commissioned Sep 1987

BURNY
Builder Zhdanov Yard, St Petersburg, Russia
Laid down 1984
Launched Feb 1987
Commissioned Aug 1988

GREMYASHCHY
Builder Zhdanov Yard, St Petersburg, Russia
Laid down 1984
Launched Jun 1987
Commissioned Nov 1988



Bespokoiny, *first of the Type 956A ships steams past at the end of BALTOPS '95* (Jane's Defence Weekly/Kathleen Bunten)

BYSTRY

Builder	Zhdanov Yard, St Petersburg, Russia
Laid down	1985
Launched	Dec 1987
Commissioned	Feb 1989

RASTOROPNY

Builder	Zhdanov Yard, St Petersburg, Russia
Laid down	1986
Launched	Jun 1988
Commissioned	Dec 1989

BEZBOYAZNENNY

Builder	Zhdanov Yard, St Petersburg, Russia
Laid down	1986
Launched	Mar 1989
Commissioned	Sep 1990

BEZUDERZHNY

Builder	Zhdanov Yard, St Petersburg, Russia
Laid down	1987
Launched	Jun 1990
Commissioned	Mar 1991

Type 956A

BESPOKOINY

Builder	Zhdanov Yard, St Petersburg, Russia
Laid down	1987
Launched	Feb 1992
Commissioned	Sep 1992

NASTOYCHIVY

Builder	North Yard, St Petersburg, Russia
Laid down	1987
Launched	Jun 1991
Commissioned	30 Mar 1993

BESSTRASHNY

Builder	North Yard, St Petersburg, Russia
Laid down	1987
Launched	Dec 1991
Commissioned	Apr 1994

SOBRAZITELNY

Builder	North Yard; St Petersburg, Russia
Laid down	1988
Launched	23 May 1994
Commissioned	1995

300 LET ROSSIYKOMY

Builder	North Yard, St Petersburg, Russia
Laid down	1989
Launched	1995
Commissioned	1997

ALEKSANDER NEVSKY

Builder	North Yard, St Petersburg, Russia
Laid down	1990
Launched	1996
Commissioned	1998

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

P-270 Moskit (NATO = SS-N-22 'Sunburn') medium-range anti-ship missiles

There are eight SS-N-22 launcher-containers, situated in two groups of four on either side of the bridge. This ramjet-powered Mach 2 missile system is designed to reach the target so fast that the enemy, even if using Aegis-equipped ships with SM-2 missiles, will have insufficient time in which to react. The missile has four clipped-delta wings and four smaller tail surfaces of similar shape, all of which are folded when the missile is in the launcher. The launch tubes are inclined at an angle of 15° and there are no reloads. The fire-control system is based on the Top Steer/Plate Steer air and surface search radar, which has a secondary tracking function for anti-ship missiles. The fire-control system also receives data from the Big Bulge I/J-band radars carried by Ka-25 'Hormone B'/Ka-27 'Helix B' helicopters for Over-The-Horizon (OTH) targeting.

An engagement starts with data on the location of both launcher and target being fed into the missile from the fire-control system, following which, the doors at the front and at the rear of the launcher cell open and the booster ignites. The missile may be launched to engage targets in a 120° arc based upon the ship's course. Once clear of the launcher, wings and tail surfaces deploy and the missile briefly rises, before dropping to its cruising altitude of 20 m, by which time the ramjet is operating. The active radar seeker then searches for the target and homes upon it when 'lock on' is achieved. In the event of jamming, the seeker has a home-on-jam capability.

At a speed of Mach 2, the missile takes 2 minutes to cover its full range and the manufacturers claim that 1 to 2 missiles could incapacitate a destroyer, while 1 to 5 missiles could sink a 20,000 tonne merchantman. An extended-range missile (3M80E) is now available with a range of 65 n miles (120 km) although whether this is being supplied to India is not known.

The Type 956A ships (*Bespokoiny* onwards) carry a longer-range version of SS-N-22 with extended launch tubes.

Specifications

Length: 9.38 m (30.8 ft)
Diameter: 130 cm (51 in)
Wing span: n/k
Weight: 3,950 kg (8,710 lb)
Speed: Mach 2
Range:
3M80 missile: 48 n miles (90 km)
3M80E missile: 65 n miles (120 km)
Guidance: Inertial
Warhead: 300 kg semi-armour-piercing (661.5 lb)

Manufacturer/Contractor

Raduga, Moscow, Russia.

SURFACE-TO-AIR MISSILES (SAM)

SA-N-7 'Gadfly'/SA-N-17 'Grizzly' local area defence system

The Sovremennys are fitted with the M-22 Uragan local area air defence system, with two single-rail launchers, which resemble the US GMLS Mk 13 and can be reloaded in 12 seconds. One launcher is situated on top of a deckhouse on the foredeck, the other immediately abaft the flight deck, and beneath each there is a 22-missile magazine, for a ship total of 44 missiles.

M-22 Uragan is a modular local area air defence system, and has been designed specifically to conduct multitarget engagements. The system can operate autonomously, but can also be linked to either a tactical data handling system or to a command and weapon control system. The associated fire-control radar is Front Dome, of which there are six, while target designation is through the ship's 3D air search radar. The ships have six channels of fire and can launch a missile every 6 seconds.

There are two types of missile, although it should be noted that the missile launchers and fire-control systems for both are the same. Type 956 ships (the first thirteen hulls) use the SA-N-7 (Russia = 9M38M1) missile, which has a solid propellant booster-sustainer, employs semi-active radar homing and is capable of manoeuvres up to 23 *g*.

Type 956A ships (*Bespokoiny* onwards) use the SA-N-17 (Russia = 9K37) missile, which is longer than SA-N-7 to accommodate a higher energy motor, increasing acceleration and giving a maximum speed of Mach 3.5, compared to Mach 2.5 for SA-N-7.

According to the manufacturer's literature the system is capable of engaging aircraft and missiles travelling at up to 830 m/s (Mach 2.5), although subsonic missiles travelling at 330 m/s may also be engaged. Crossing target aircraft may be engaged at distances up to 10 n miles (18 km) while missiles may be engaged at ranges up to 3.25 n miles (6 km). The double-round kill probability against aircraft ranges from Pk = 0.81 to 0.96, and against missiles is Pk = 0.43 to 0.86. Reaction time is 16 to 19 seconds when the ship is on alert, or 3 minutes from a 'cold' start.

Specifications

	SA-N-7	SA-N-17
Length	5.55 m (18.2 ft)	6.5 m (21.3 ft)
Diameter	40 cm (15.75 in)	40 cm (15.75 in)
Wing span	86 cm (33.8 in)	80 cm (31.5 in)
Weight	690 kg (1,521 lb)	720 kg (1,587 lb)
Warhead	70 kg (HE) (154.3 lb)	70 kg (HE) (154.3 lb)
Speed	Mach 2.5	Mach 3.5
Range	1.5-16 n miles (3-30 km)	
Altitude	30-22,000 m (98-72,182 ft)	
Guidance	Inertial and semi-active radar	

Bezboyaznenny. *Note SA-N-7 launcher, AK-130 twin mounting and the two, twin-barrelled chaff launchers. There are chutes for launching mines over the transom, but there is no door for a VDS* (H & L van Ginderen Collection)

TABLE: SUMMARY OF SYSTEM DESIGNATIONS

	Russia		NATO	
	Number	**Name**	**Number**	**Name**
System	M-22	Shtil		
Missile	9M38M1	Ouragan	SA-N-7	Gadfly
System		Ezh		
Missile	9K37	Smersch	SA-N-12	Grizzly
Fire-control radar		Orekh		Front Dome

TUBES

There are two sets of twin 533 mm (21 in) torpedo tubes in the waist. They launch the normal range of Russian torpedoes.

GUNS

AK-130 130 mm/70 calibre twin

There are two twin 130 mm mountings, one on the foredeck, the second right aft. This mounting entered service with the destroyer *Sovremenny* in August 1980 and features two water-cooled 9.1 m long barrels of monobloc construction. The barrels fit into sleeves which are part of a common cradle but there are separate recoil cylinders under each gun. Unlike most similar Soviet weapons the elevating mass is close to the front of the turret. The steel turret is dome-shaped and sits on a 1.5 m high cylindrical steel base, which is believed to penetrate the deck to a depth of about 7 m. The turret features an electro-optic sensor on the right of the elevating mass at the front and also contains an automatic loading system; it seems likely that the mounting will carry 80 to 90 rounds.

The L/70 fire-control radar is 'Kite Screech,' a G/I-band radar incorporating monopulse tracking. One such radar controls up to two guns and it is likely that the radar compartment for this sensor also acts as the fire-control centre. In the shore bombardment role it may be used with the electro-optic sensor which has the NATO codename 'Squeeze Box'.

Bezboyaznenny. *The forward part of the ship is dominated by the twin 130 mm gun and the quad SS-N-22 launch group, but there is also an SA-N-7 launcher (immediately behind the 130 mm turret) and two AK-630 CIWS (one can be seen above the SA-N-7 launcher)* (H & L van Ginderen Collection)

Specifications

Length of barrel: 70 calibres

Muzzle velocity: 950 m/s (3,117 ft/s)

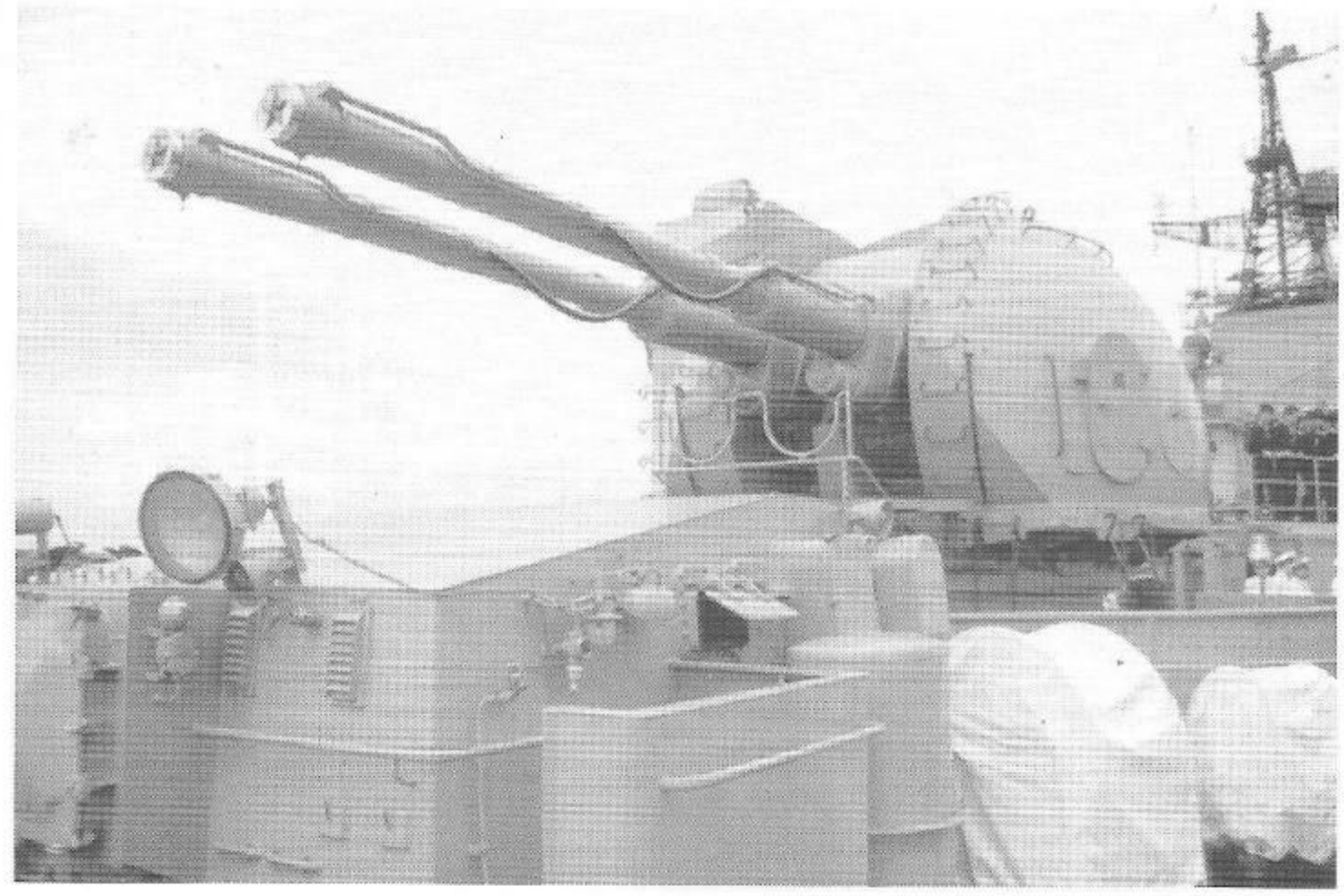
Traverse: 360°
Elevation: −15 to +85°
Ammunition: 27 kg (59.5 lb)
Rate of fire: 80 rds/min/mounting
Range, anti-surface: 16 n miles (29.5 km)

30 mm/65 AK 630 Gatling-type close in weapons system

There are four 30 mm/54 calibre AK-630 Gatling close in weapon systems (CIWS), with two just in front of the bridge screen and two aft, either side of the hangar, unlike many other Russian ships, which have these mountings grouped together around the foot of the mainmast. These have five roles, engaging anti-ship missiles, aircraft, small surface vessels, drifting mines and unprotected targets ashore. The AO-18 weapon is a water-cooled, six-barrelled, Gatling-principle weapon with fixed breech block and revolving barrels. The weapon is believed to operate in a similar manner to that of the Phalanx, firing bursts of up to 400 rounds but, unlike the US weapon, AK-630 features a separate radar director (Drum Tilt)

Specifications

Calibre: 30 mm
Length of barrel: 65 calibres
Number of barrels: 6
Muzzle velocity: 890 m/s (2,920 ft/s)
Cooling: Water
Traverse: 360° at 70°/s
Elevation: −12 to +88° at 50°/s
Crew: 1 (off mount)
Range: 4,000 m (radar fire control), 5,000 m (electro-optic fire control)
Rate of fire: 4,000-5,000 rds/min
Magazine: 2,000 rds
Weight of complete round: 1.224 kg (2.7 lb)
Ammunition types: UOF-84 HE-I, weight 384 g; UOR-84 HE-T, weight 388 g
Fuze: MG-32 point impact (both rounds)



AK-130 130 mm mount aboard a 'Sovremenny' class destroyer. Rate of fire is 80 rounds per minute with a range of 16 n miles (29.5 km) (Jane's/H M Steele)

ANTI-SUBMARINE MORTARS

RBU-6000

There are two 12-tube RBU-6000 mortars located aft, either side of the flight deck. The mounting can traverse through 360° although practical limits due to its position are ±90° and elevation limits are −15° to +60°. Loading is automatic from a below-deck magazine. It is estimated that the rockets weigh 110 kg (242.5 lb), with a 25 kg (55 lb) warhead. Pairs of tubes are fired in sequence. The RGB-60 rocket is fitted with an impact-time fuze, which detonates either on hitting a solid object (such as a submarine) or reaches a preset depth. Firing is usually conducted in a full salvo of 12 rockets, but it is also possible to fire single rockets, or four- or eight-rocket salvos, if the tactical situation requires it. The warhead weighs 31 kg (68 lb).

MINES

There are mine rails for up to 40 mines.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

Foot Ball B

There are four Foot Ball B radomes, covering EW antenna arrays. There appear, however, to be variations in the fit, with some ships having 2 Bell Shroud and 2 Bell Squat.

Half Cup

There are six Half Cup laser intercept devices in *Boyevoy* onwards.

DECOYS

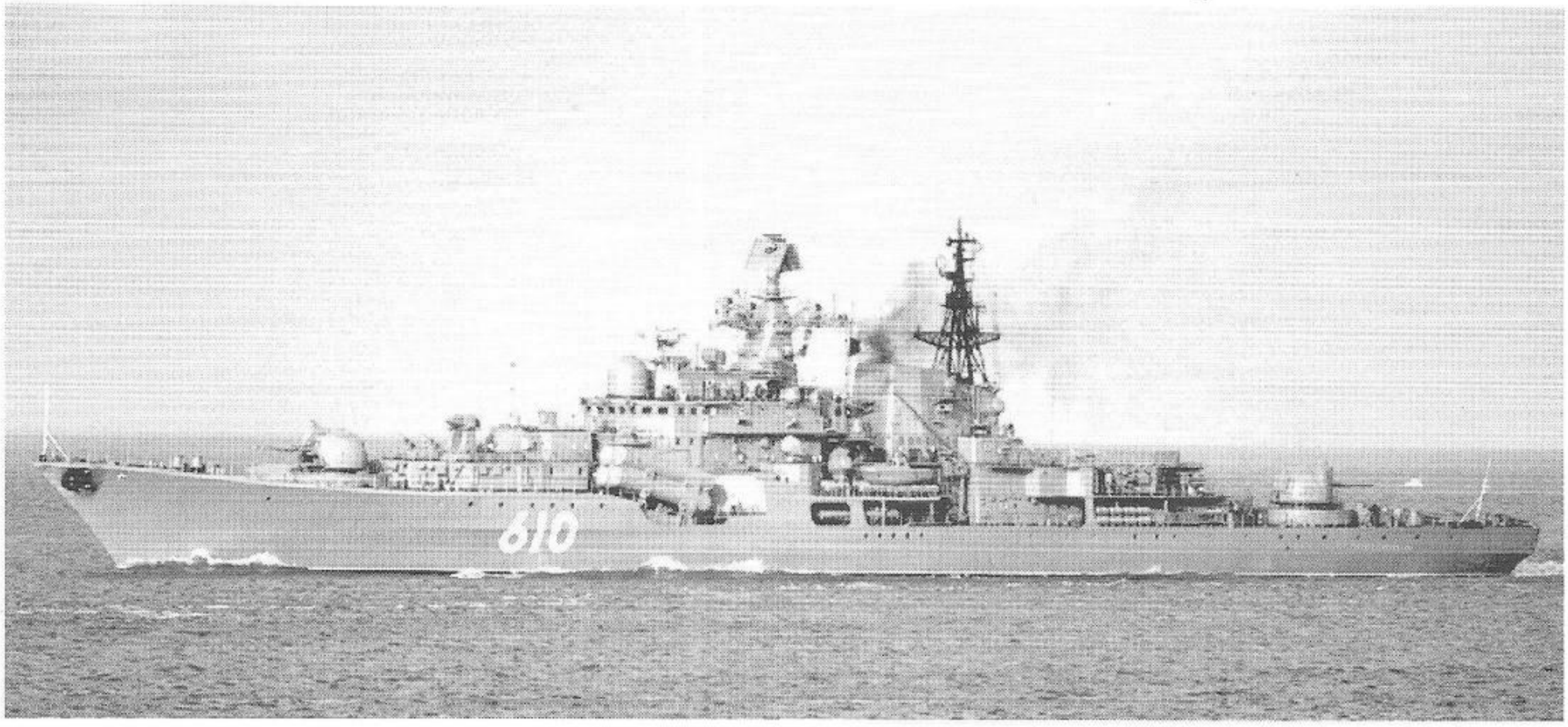
PK-10

All Sovremennys have the PK-10 naval decoy system, consisting of ten KT-216 launchers, a control console and munitions. The launcher unit has 10—120 mm barrels, set at an angle of about 45°. The launcher appears to be turnable. The control console appears to be a relatively simple design capable of controlling up to four launchers.

There are three types of munition, all for seduction purposes. SR-50 is a chaff round with a payload of 11 kg (24.2 lb), SOM-50 is a heat-seeker/laser-guided missile seduction round with 7.3 kg (16.1 lb) payload, and SK-50 is a combined round with 9.1 kg (20.1 lb) payload.

PK-2

There are also two PK-2, twin-tube launchers.



Nastoychivy *in 1995.*

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Squeeze Box

One Squeeze Box is fitted. This is an optronic director and laser rangefinder. This appears to be used in conjunction with Kite Screech for anti-ship and shore bombardment missions by the 130 mm guns.

Shot Dome

Shot Dome is a small radome, apparently with a communications or weapons control role. There are two:

Optical director for SAM
Datalink system.

SONARS

Bull Horn

Bull Horn (Russian designation: MG-335 *Platina*) is a hull-mounted, active search and attack sonar, operating at low and medium frequencies.

Whale Tongue

Whale Tongue is a hull-mounted, active search and attack sonar, operating at medium frequency.

RADARS

	Role	Ships	Equipment	Frequency band
Search	Air search	First two 3rd and 4th ships Remainder	Top Steer* Plate Steer* Top Plate*	D/E D/E D/E
	Surface search	All	3 × Palm Frond	I
Fire control	SA-N-7/17	All	6 × Front Dome	F
	130 mm guns	All	Kite Screech	H/I/K
	30 mm guns	All	Bass Tilt	H/I

* Also have fire-control function for SS-N-22 system

IFF: Salt Pot A and B. High Pole A and B. Long Head.

Bezuprechny in 1990 is fitted with an air search radar which appears to combine the Flat Plate antenna of Top Plate with a back to back Strut Curve, presumably an interim solution between Strut Pair and the full Top Plate (H & L van Ginderen Collection)

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 21.2 × 15.0 m (70.0 × 49.0 ft)

HELICOPTERS

1 Ka-25 'Hormone B' or Ka-27 'Helix'.
Tacan: Two Light Bulb.

PROPULSION

Specifications
System: 4 boilers; 2 turbines; 75 MW (102,000 hp (m))
Shafts: 2, bow thruster

FURTHER INFORMATION

PROGRAMME

There are three versions of the Sovremenny design. First was the original Type 956, of which 14 were built and one has already been scrapped. These were followed by six Type 956A, of which the last two are due to join the fleet in 1998. The 21st ship is, however, sufficiently different to be classed in the West as Sovremenny II (its Russian 'type number' is not yet known). Although it is believed that this ship has been laid down, whether or not it will be completed in the current chaotic state of the Russian shipbuilding industry, remains to be seen.

Construction of the 'Sovremenny' class commenced in 1977 and all have been produced at the same yard, which was called the Zhdanov Yard, Leningrad during the Soviet era, but is now the Northern Yard, St Petersburg. The type was laid down at a rate of one per year from 1977 to 1985, but this rose to two in 1986 and no less than four in 1987, although it then reverted to one a year until 1990, when the twentieth hull (*Aleksander Nevsky*) was laid down.

The Russian type name is *eskadrenny minonosets*, which traditionally translates into English as 'destroyer' although, with a full load displacement of 7,625 tonnes it is considerably larger than ships such as the 'Kynda' class, displacing 5,600 tonnes, which the Soviet Navy itself classified as cruisers *(kreyser)*.

DESIGN

The hull is essentially the same as that of the 'Kresta' class cruisers, albeit with a raised forecastle and a stern with a broader section. It would appear, however, that the high-pressure steam propulsion system is the same. The use of steam propulsion as opposed to gas turbines, means that only one stack is needed, thus enabling the helicopter flight deck and hangar to be placed much further forward than in most other Russian cruisers and destroyers.

For a Russian ship the superstructure is quite compact. The hangar is combined with the stack and is quite short, requiring a telescopic extension to enable it fully to house its helicopter.

The fully automatic 130 mm gun was first seen in 1976. Chaff launchers are fitted on both sides of the foremast and either side of the after SAM launcher.

The Type 956A is armed with a longer-range version of SS-N-22 while the SAM system has been upgraded with the SA-N-17. There are also some variations in the sensor and EW fit.

DEPLOYMENT

Based as follows:

Northern Fleet — *Sovremenny, Otchyanny, Otlichnny, Bezuprechny, Okrylenny, Gremyashchy, Rastoropny, Bezuderzhny* and *Besstrashny.*

Pacific Fleet — *Osmotritelny, Boyevoy, Stoyky, Burny, Bystry* and *Bezboyaznenny.*

Baltic Fleet — *Bespokoiny* started trials in the Baltic in early 1992 but after a fire in August 1992 was alongside in Kaliningrad until March 1994 when she joined the Baltic Fleet; *Nastoychivy* has remained in the Baltic.

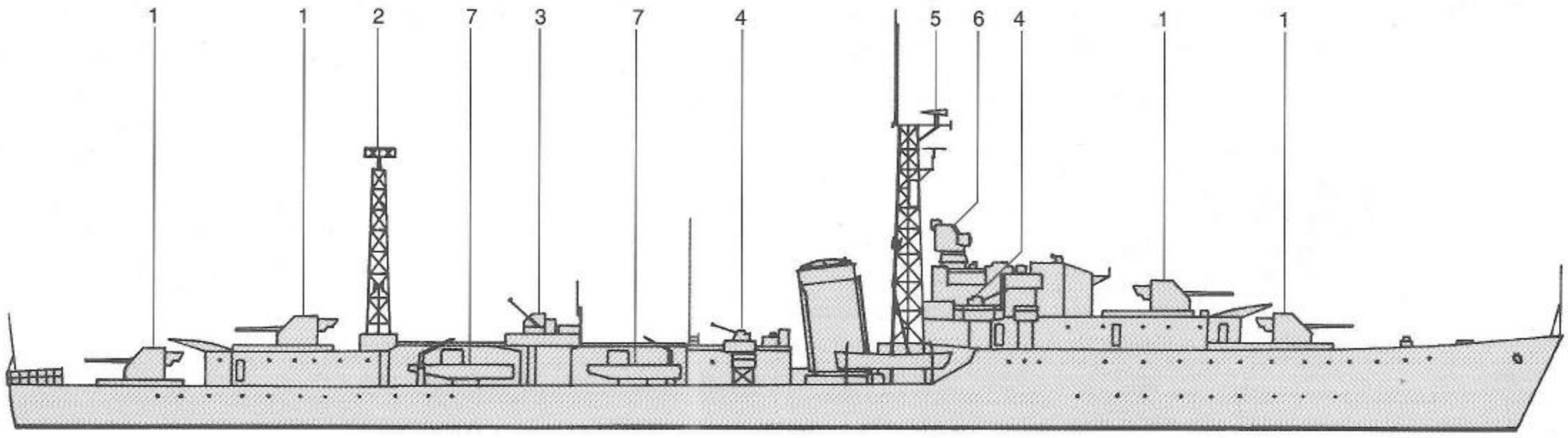
Sobrazitelny started trials in 1995.

THE FUTURE

One ship of the class has already been scrapped and the first four listed under 'Ships' are now non-operational.

Various versions have been offered for export at overseas exhibitions and there have been unconfirmed reports that the last two of the class may be sold to China.

EL FATEH ('Z' CLASS)



El Fateh ('Z' Class)
1 *Vickers 115 mm (4.5 in)/45 Mk 5 single mounts (hand-loaded)* **2** *Marconi SNW-10 radar (air search)* **3** *Bofors 40 mm (one twin)* **4** *Chinese 37 mm/63 (twin)* **5** *Racal-Decca 916 radar (surface search)* **6** *Mk 6 director with Marconi Type 275 radars* **7** *Quadruple 533 mm (21 in) torpedo tubes*

GENERAL SPECIFICATIONS

Country of Origin: UK
Operator: Egypt
Type: 'Z' Class

Class: EL FATEH

Purchased: 2
Active: 1

Displacement:
standard: 1,730 t
full load: 2,575 t

Dimensions
Length: 110.6 m (362.8 ft)
Beam: 10.9 m (35.7 ft)
Draught: 4.9 m (16 ft)

Speed: 24 kts
Range: 2,800 n miles at 20 kts

Complement: 186

SHIPS

EL FATEH (921)

Builder	Wm Denny & Bros, Dumbarton, UK
Laid down	19 May 1942
Launched	5 Jun 1944
Commissioned (RN)	22 Dec 1944 *(Zenith)*
Sold to Egypt	1955
Commissioned (Egyptian Navy)	July 1956 (*El Fateh* (921))

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

Strela 2 (NATO = SA-N-5 Grail)

There are two Strela 2 (NATO = SA-N-5 Grail) mountings, each with four GRP launcher-containers for the 9M43M missiles. These missiles use an uncooled lead sulphide infra-red seeker, operating in the 1.7 to 2.8 µm range and with a spinning reticle, centre-null tracking system with a 1.9° field of view. On acquiring the target, the operator activates the thermal battery and waits for the audio signal which indicates that the seeker has acquired. The trigger is partially pulled to activate the missile gyros, which are warmed up in 4 to 6 seconds. The operator uses stadia reference marks in the optical sight to compute the lead angle to the target, then fully engages the trigger to launch the missile. The booster burns for 0.05 seconds to eject the missile from the launch tube at a speed of 28 m/s (92 ft/s) and to spin it. Then, at a distance of 6 m (20 ft), the sustainer ignites and the trailing fins pop out. The missile homes on the 'hottest' part of the aircraft.

Specifications

Length: 1.45 m (4.76 ft)
Diameter: 7 cm (2.75 in)
Weight: 9.97 kg (21.98 lb)
Speed: Mach 1.7
Range: 2.6 n miles (5.5 km)
Altitude: 50-4,500 m (164-14,800 ft)
Warhead: 1.1 kg armour-piercing RDX
Fuze: Impact

Manufacturer/Contractor

Fakel.

TUBES

8—21 in (533 mm) (quad) tubes. Type 53-56; anti-surface.

GUNS

Vickers 114 mm (4.5 in) Mk 5 semi-automatic gun

El Fateh has four 114 mm (4.5 in) QF Mk V guns in single mounts. The hand-loaded gun weighs 2,859 kg (6,304 lb), has an autofretted loose barrel, jacket, removable breech ring and sealing collar, but has neither muzzle brake nor fume extractor. The barrel is 45 calibres long and has 32 grooves with a uniform 1 in 25 twist and a life of approximately 750 EFC (Equivalent Full Charges). There is a hydraulically operated vertical sliding breech block and the gun fires separate ammunition. The recoil and run-out cylinders are incorporated in the breech ring so that the total weight of the weapon is 3,368 kg (7,426 lb). There is a separate shell and cartridge hoist for each turret.

Specifications

Calibre: 114 mm
Length of barrel: 45 calibres
Muzzle velocity: 746 m/s (2,447 ft/s)
Weight of round: 25.5 kg (56.2 lb) (projectile only)
Range:
anti-ship: 10.25 n miles (19 km)
anti-air: 12,500 m (41,000 ft)
Rate of fire: 14 rds/min (Mk V gun)
Traverse: 360°
Elevation: 0 to 50°
Rate of fire: 14 rds/min

Manufacturer/Contractor

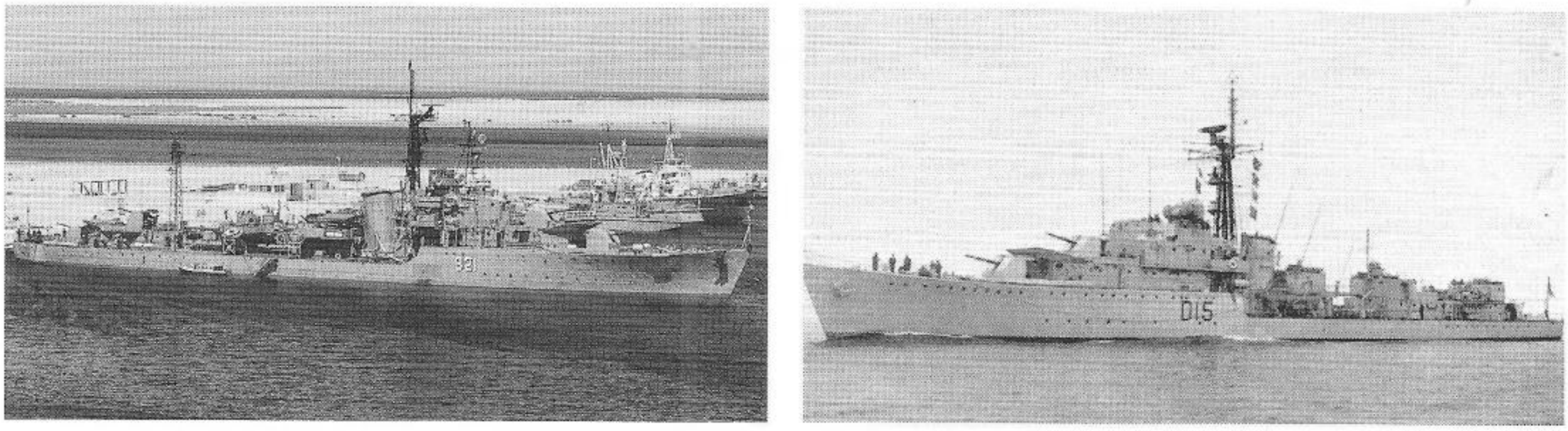
Vickers Shipbuilding and Engineering Ltd, Barrow-in-Furness, Cumbria, UK.

37 mm (W-11-M) Mountings

Among the non-British weapons fitted to this ship are six (three twin) 37 mm gun mountings. This 62.8 calibre weapon has a flash suppressor and the barrels are enclosed in separate water jackets with exposed spring recuperators, and a hydraulic recoil buffer underneath the barrel. The loading mechanism consists of guides for ammunition, which is in five-round clips, the clips being automatically removed on the loading tray. The first round is loaded manually into the breech. The breech block rises and the gun fires when the firing pin strikes the cartridge percussion cap. Upon recoil, the breech block opens and extractor arms propel the case along the loading tray and down an ejection chute. The recoil forces activate the loading mechanism and allow following rounds to be rammed automatically into the breech.

Specifications

(W-11-M)
Calibre: 37 mm
Length of barrel: 62.8 calibres
Muzzle velocity: 886 m/s (2,907 ft/s)
Traverse: 360° at 17°/s
Elevation: −10 to +85° at 13°/s
Rate of fire: 80 rds/min/barrel



Destroyer El Fateh *(921) in 1994 (left) compared with sister-ship* Cavendish *in 1947 (right) shows that the Egyptian Navy has made very few major alterations to this 50-year old ship, apart from an additional mast aft* (Left: H & L van Ginderen Collection/Right: Jane's)

Ammunition:
(projectile): 0.732 kg (1.6 lb)
(complete round): 1.42 kg (3.11 lb)

Range:
anti-surface: 2.2 n miles (4 km)
anti-air: 3,000 m (9,843 ft)
Crew: 3

Ammunition (HE-T)
Projectile Weight: 708 g
Explosive charge: 36 g (RDX/aluminium)
Muzzle velocity: 886 m/s (2,907 ft/s)

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Mk 6 director control.
Fly 4 director.

RADARS

Marconi SNW-10

El Fateh is the last known user of the Marconi SNW-10 air search radar.

Specifications
Frequency band: D
Peak power: 450 kW
Beam: 19°
Pulsewidth: 3.8 µs
Pulse repetition frequency: 250/500 pps
Scan rate: 10 rpm

Racal Decca 916

The Racal Decca 916 is an I-band surface search/navigation radar.

Marconi Type 275

The Type 275 is a 1940s vintage, F-band, fire-control radar for the 114 mm (4.5 in) guns.

PROPULSION

Specifications
System: Steam-turbines
Main machinery: 2 Admiralty boilers; 2 Parsons turbines; 30 MW (40,000 hp)
Shafts: 2

FURTHER INFORMATION

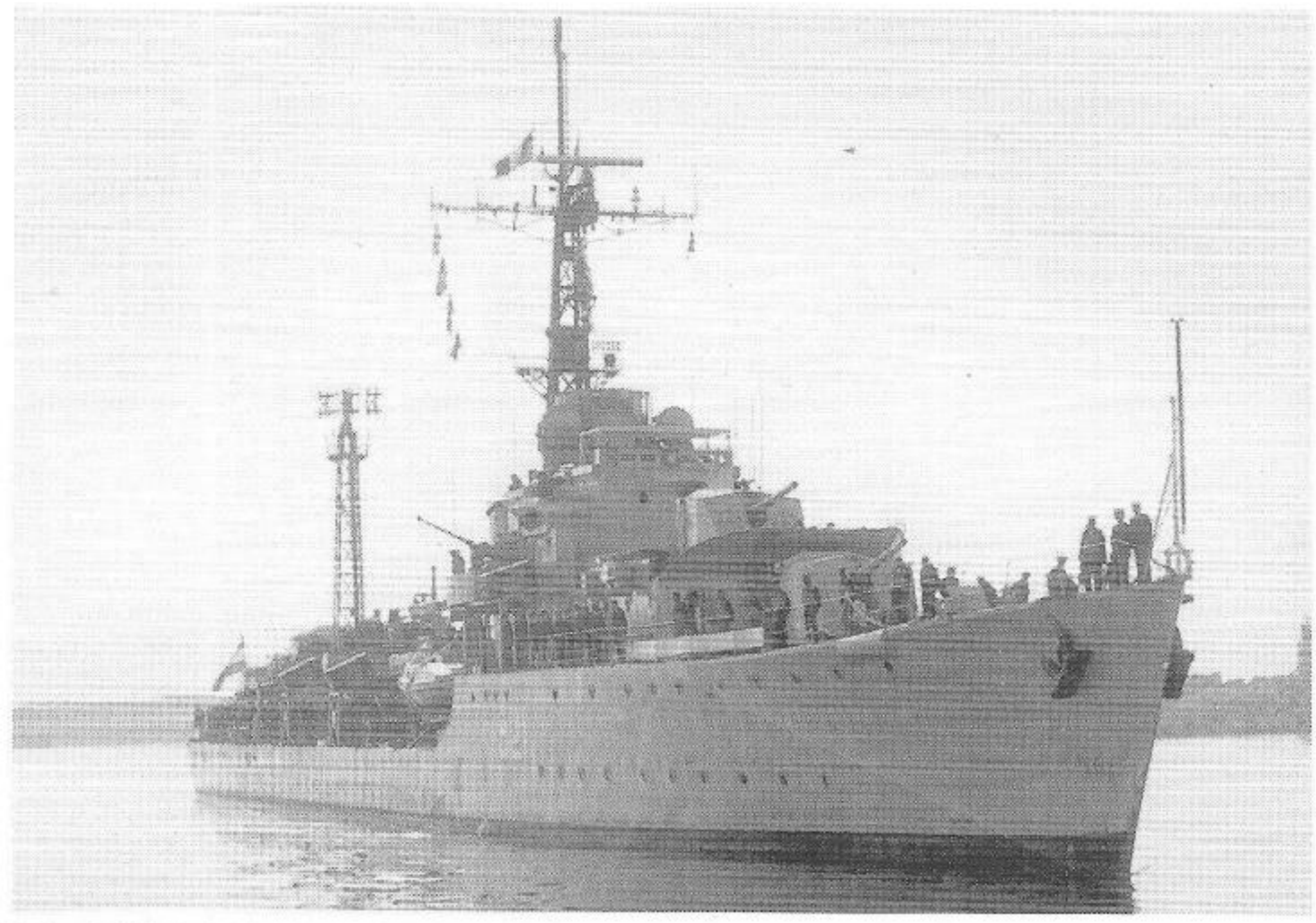
PROGRAMME

Some 179 generally similar, single-stack destroyers were constructed for the British and Allied navies during the Second World War, and the Egyptian *El Fateh* is now the only survivor still in service. It was one of eight 'Z' class ships built between 1942 and 1944, the class being a progressive development of the previous 'W' class, but with four 4.5 in rather than four 4.7 in guns and improved fire control. They continued to serve after the war, but in 1955 four were sold to the Middle East, two to Israel and two to Egypt. By a curious coincidence, each navy has lost one to the other in combat. The Israeli *Elath* (ex-*Zealous*) was sunk by three Egyptian-launched Styx missiles off Port Said on 21 October 1967, while the Egyptian *El Qaher* (ex-*Myngs*) was sunk by Israeli aircraft in the Red Sea on 16 May 1970. The Israeli Navy scrapped *Yaffa* (ex-*Zodiac*) in 1972, but the Egyptian Navy has maintained *El Fateh* in service as a sea training ship and it could still be used operationally in an emergency. It is understood that it will be retained in service until at least the year 2000.

MODERNISATION

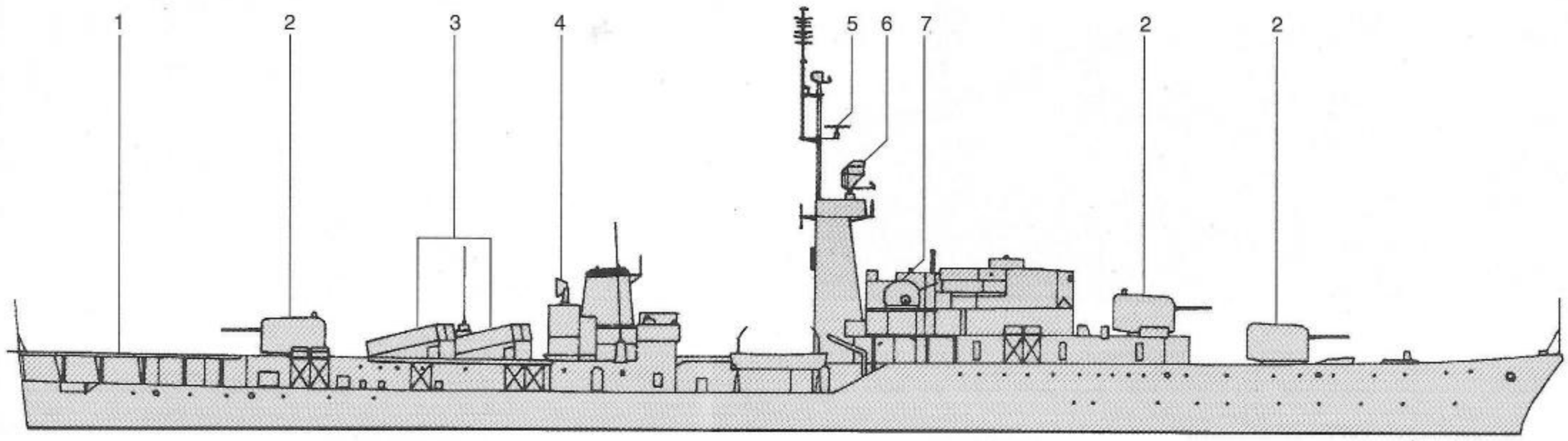
El Fateh has undergone a series of modernisations. Following its purchase from the UK in 1955, it was refitted by John I. Thornycroft & Co Ltd, Woolston, Southampton, UK before being delivered in July 1956. It was again modernised by J S White & Co Ltd, Cowes, in 1963/64. It has subsequently been modernised in Egyptian yards.

The Bofors 40 mm AA guns have been replaced by Chinese 37 mm guns and the British sonars and ASW weapons (depth charges and Squid) have been removed, without replacement. Another refit took place in 1992/93, the work including renewing the boilers and installing two SA-N-5 mountings.



El Fateh *(921) visiting the Italian port of Messina* (H & L van Ginderen Collection)

FERRE (DARING)



Ferre (Ian Sturton)
1 *Flight deck* **2** *Twin 114 mm (4.5 in)/45 Mk6* **3** *MM 38 exocet anti-ship missiles (eight)* **4** *RTN 10X radar (fire control)* **5** *Racal Decca TM 1226 radar (navigation)* **6** *Plessey AWS-1 radar (air/surface search)* **7** *Twin Breda 40 mm/70*

GENERAL SPECIFICATIONS

Country of origin: UK
Operator: Peru

Class: FERRE (ex-British 'Daring')

Built: 8
Purchased: 2
Active: 1

Displacement:
standard: 2,800 t
full load: 3,600 t

Dimensions
Length: 118.9 m (390 ft)
Beam: 13.1 m (43 ft)
Draught: 5.5 m (18 ft)

Speed: 32 kts
Range: 3,000 n miles at 20 kts

Complement: 297

SHIPS

FERRE (DM 74)		**Launched**	29 Mar 1949	**Pre-delivery refit**	1970-1973
Builder	Yarrow, Glasgow, UK	**Commissioned (UK)**	28 Apr 1953 (*Decoy* (D 106))	**Commissioned (Peru)**	April 1973 (*Ferré* (DM 74)
Laid down	22 Sep 1946	**Sold to Peru**	December 1969		

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Exocet MM 38 medium-range anti-ship missile

The Exocet anti-ship missile has achieved some noteable successes in both the Falklands (Malvinas) and Gulf wars.

Ship-launched MM 38 Exocets are carried in two- or four-round launcher-containers designated ITS (*Installation de Tir Standard*), within which they are suspended from a launch rail in the ceiling. These launcher-containers are inclined at an angle of 12° to the horizontal.

In addition to the launcher installations there is a control console. Optional features of the system include a co-ordinate converter to interface the missile with the ship's sensors, and de-icing equipment.

Targets are acquired by the ship's search radar and the operator then aligns the axial gyros in the target's direction and begins the initiation sequence. This involves turning on the thermal battery, releasing the mechanical safety locks, igniting the booster and, finally, breaking the umbilical cord; the total process takes some 60 seconds. Exocet has a 105° off-axis engagement envelope and can perform one 15° change of course during its flight.

The attack consists of three phases:

Cruise phase. The cruise phase starts as the missile clears the container and, powered by the sustainer motor, flies towards the general location of the target at a height of about 100 m (328 ft) which is low enough to reduce the chance of detection but adequate for target acquisition. This phase can be as long as 12 n miles (23 km) and ends when the seeker acquires the target. This seeker is a Dassault Electronique ADAC (Auto Directeur Anti-Clutter) active monopulse radar, working in the I-band (8-10 GHz), which has a typical range of 13 n miles (24 km) against FACs.

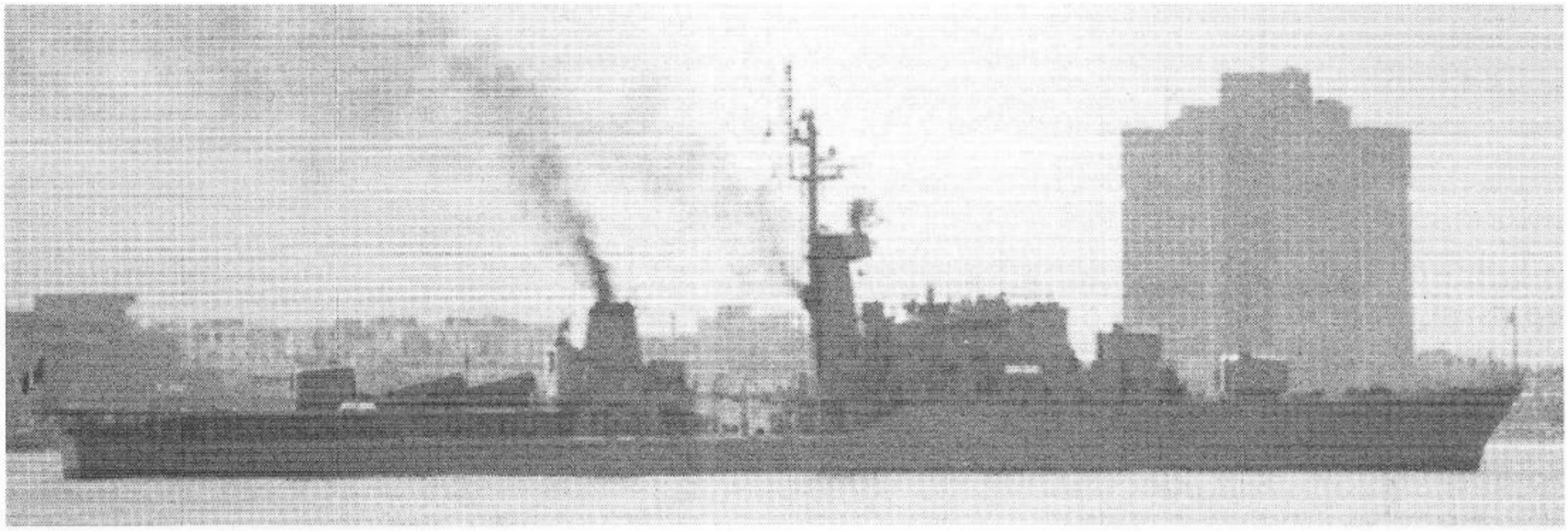
Approach phase. On detecting the target, the missile descends to 9 to 15 m (30 to 50 ft) in the approach phase.

Terminal phase. During this final phase, the missile descends to 8 m (26 ft) (2 to 5 m (6.5 to 16 ft) in a calm sea) for a sea-skimming run in to the target.

A salvo may be fired in 12 to 20 seconds.

Specifications

(MM 38)
Length: 5.21 m (17.1 ft)
Diameter: 35 cm (13.8 in)
Wing span: 1.00 m (3.28 ft)
Weight: 735 kg (1,620 lb)



Ferré *in 1994. The flight deck can only offer limited facilities. Note the Exocet launchers between the after turret and the stack*

Speed: Mach 0.9
Range: 2-22.5 n miles (4-42 km)
Guidance: Inertial and active radar
Sustainer motor: SNPE Eole alloy-cased CDB; weight 151 kg (333 lb); max burn time 93 s
Booster: 100 kg (220 lb) SNPE Epervier boost motor; burn time of 2.4 s
Warhead: Luchaire 165 kg (364 lb) fragmentation warhead
Fuzes: Delayed impact fuze and autopilot-controlled proximity fuze

Manufacturer/Contractor
Aerospatiale Tactical Missiles, Chatillon Cedex, France.

GUNS

Vickers 114 mm (4.5 in) Mk 6 semi-automatic mounting
Ferré has three twin turrets in 'A', 'B' and 'C' positions, each mounting twin 4.5 in/45 QF Mk V guns. The gun weighs 2,859 kg, has an autofretted loose barrel, jacket, removable breech ring and sealing collar, but has neither muzzle brake nor fume extractor. The barrel is 45 calibres long and has 32 grooves with a uniform 1 in 25 twist and a life of approximately 750 EFC (Equivalent Full Charges). There is a hydraulically operated vertical sliding breech block and the gun fires separate ammunition. The recoil and run-out cylinders are incorporated in the breech ring so that the total weight of the weapon is 3,368 kg. The electrohydraulically powered turret (RP 41 Mk 6) incorporates two Mk V guns and hydraulic rammers. Each gun has a separate shell and cartridge hoist, which are served by 17 men below decks.

Specifications
(V gun)
Calibre: 114 mm (4.5 in)
Length of barrel: 45 calibres
Muzzle velocity: 746 m/s (2,447 ft/s)
Weight of round: 25.5 kg (56.2 lb) (projectile only)
Range:
anti-ship: 10.25 n miles (19 km)
anti-air: 12,500 m (41,000 ft)
Rate of fire: 20 rds/min (Mk V gun)

Mountings (6)
Weight: 45 t
Traverse: 360°
Elevation: 0 to +80°
Crew: 20

Manufacturer/Contractor
Vickers Shipbuilding and Engineering Ltd, Barrow-in-Furness, Cumbria, UK.

40 mm L/70 Compact
The OTOBREDA 40 mm L/70 Compact twin mounting is designed for use against high-performance combat aircraft, anti-ship missiles and surface targets. It consists of two 40 mm guns mounted 300 mm apart, a feeding system with magazine, a local control panel, a power supply rack, a converter and an air-water panel.

Specifications
Calibre: 40 mm
Length of barrel: 70 calibres (2.8 m)
Muzzle velocity: 1,000 m/s (3,281 ft/s)
Max range: 6.75 n miles (12.5 km)
Effective range:
anti-surface: 3.25 n miles (6 km)
anti-air: 4,000 m (13,124 ft)
Rate of fire: 600 rds/min
Ammunition: 2.4 kg (HCHE, PFHE), 2.5 kg (HE-T)
Traverse: 360° at 90°/s
Elevation: −3 to +85° at 60°/s

Manufaturer/Contractor
OTOBREDA, La Spezia, Italy.

COMMAND AND CONTROL SYSTEMS

RADARS

Plessey AWS-1

Specifications
Role: air search
Band: D/E
Range: 60 n miles (110 km)
Beam: 1.5 × 40°
Peak power: 750 kW
Gain: 32 dB
Pulsewidth: 0.35/1.5 µs
PRF: 1,000/400 pps
Scan rate: 10/20 rpm
Range: 60 n miles (110 km)

Manufacturer/Contractor
Plessey.

Racal-Decca Type 1226
Role: Navigation
Band: I
Beam: 1.2°
Peak power: 25 kW
Gain: 30 dB
Pulsewidth: 0.05/0.25/1 µs
Scan rate: 28 rpm

Manufacturer/Contractor
Racal-Decca.

SPG-70 (RTN-10X)
Role: fire control (Argo)
Band: I/J
Range: 22 n miles (40 km)
Peak power: 200 kW
Pulsewidth: 1.5 µs
PRF: 450-550 pps

Manufacturer/Contractor
Alenia Elsag Sistemi Navali, Rome, Italy.

Diamond *while in British service showing the original form of the ship* (Jane's)

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 15.8 × 13.1 m (52 × 43 ft) (approximate)
Hangar: None

PROPULSION

Specificatons
System: Steam turbines
Main machinery: 2 Foster-Wheeler boilers; 45.7 kg/cm² (650 psi); 454° C (850° F); 2 English Electric turbines; 40 MW (54,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

A total of 12 'Daring' class destroyers was built between 1945 and 1952, of which eight were for the British Navy. The other four were built in Australia for the Australian Navy, one of which was lost in a collision and replaced by one of the British ships. Two of the remaining British ships were sold to Peru in 1970, and one of these, *Ferré*, is now the last of the class to remain operational, all the others having long since been scrapped.

DESIGN

The Darings were the first British post-Second World War destroyers, although they were officially rated as 'Daring' class ships and treated in most respects as light cruisers. Their armament comprised three twin 114 mm (4.5 in) guns, up to six 40 mm Bofors, two banks of quintuple torpedo tubes and a Squid ASW mortar.

MODERNISATION

Whilst in British service, all ships in the class received a major refit in the mid-1960s. Also, in 1963 *Decoy* was fitted with a Sea Cat SAM launcher, but although the trials were successful, it was later removed.

The two ships sold to Peru in 1970 were given a major refit at the Cammell-Laird yard in Birkenhead between 1970 and 1973. The work done included fitting eight Exocet launchers, the installation of various new electronic equipment including a Plessey AWS-1 radar, and enclosing the foremast (which also contained the forward stack).

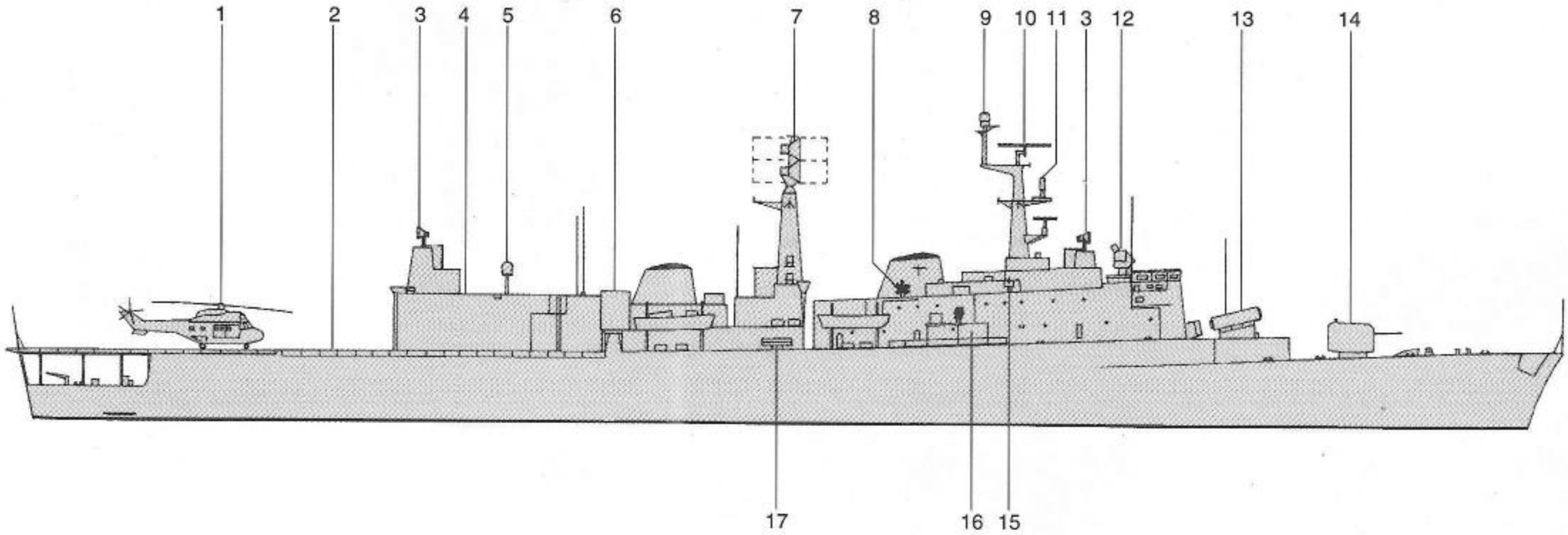
A helicopter flight deck was fitted in 1975, but two years later a major refit included removal of the after 114 mm (4.5 in) mounting, the construction of a hangar and strengthening of the original flight deck. Other work included raising and streamlining the after stack, removing the Squid mortar and sonar, and installing twin Breda 40 mm mounts in the bridge wings in place of the single Bofors mounts.

Some years later the hangar was removed and the third 4.5 in turret replaced.

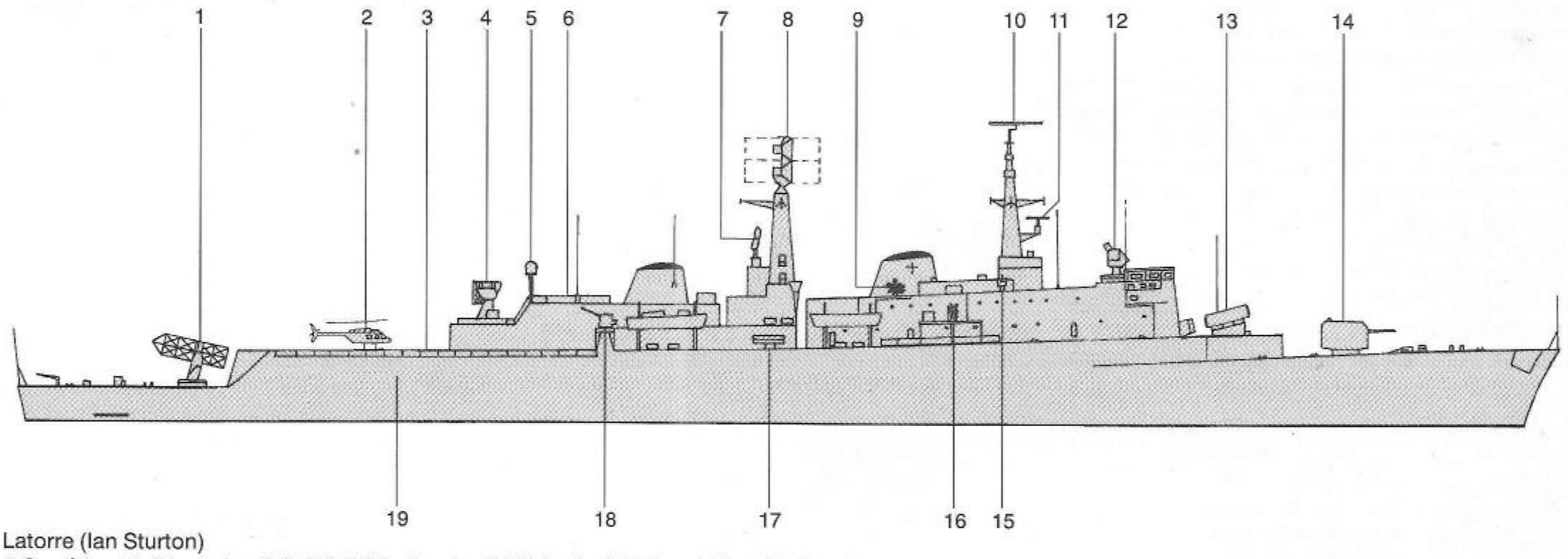
THE FUTURE

The second ship of the class, *Palacios* (ex-*Diana*) was deleted in 1993 and it is assumed that *Ferré* will not remain in service for much longer. It is reported that when *Ferré* is deleted, the Exocet missiles will be transferred to the cruiser, *Almirante Grau*.

PRAT (COUNTY)



Blanco Encalada (Ian Sturton)
1 *NAS 3325C Super Puma* **2** *Flight deck* **3** *Elta EL/ON-221 GM (for Barak SAM)* **4** *Hangar (door at after end)* **5** *Satcom* **6** *Barak I SAM system* **7** *Type 965M* (Cochrane), Type 966 (Blanco Encalada) *radar (air search)* **8** *Corvus chaff launcher* **9** *New ECM/ESM antenna arrays* **10** *Type 992 Q/R radar (surface search)* **11** *Type 978/1006 radar (navigation)* **12** *Type 903 radar director (guns)* **13** *4 × MM 40 Exocet SSM* **14** *Twin 114 mm (4.5 in) guns Mk 6* **15** *Oerlikon 20 mm cannon* **16** *Barricade chaff launchers* **17** *Mk 32 triple 324 mm torpedo tubes*



Latorre (Ian Sturton)
1 *Sea Slug Mk 2 launcher* **2** *Bell 206B helicopter* **3** *Flight deck* **4** *Type 901 radar (Sea Slug system)* **5** *Satcom* **6** *Hangar (door on port side)* **7** *Type 277M (height finder)* **8** *Type 965* (Latorre) *Type 965M (Prat) radar (air servaillance)* **9** *Corvus chaff launcher* **10** *Type 992 Q/R radar (surface search)* **11** *Type 978/1006 radar (navigation)* **12** *Type 903 fire control (guns)* **13** *4× MM 40 Exocet SSM* **14** *Twin 114 mm (4.5 in) guns Mk 6* **15** *Oerlikon 20 mm cannon* **16** *Barricade decoy launcher* **17** *Mk 32 triple 324 mm torpedo tubes* **18** *Bofors 40 mm (replaced by Barak SAM)* **19** *Sea Slug SAM magazine*

GENERAL SPECIFICATIONS

Country of origin: UK
Operator: Chile

Class: PRAT (ex-British 'County')

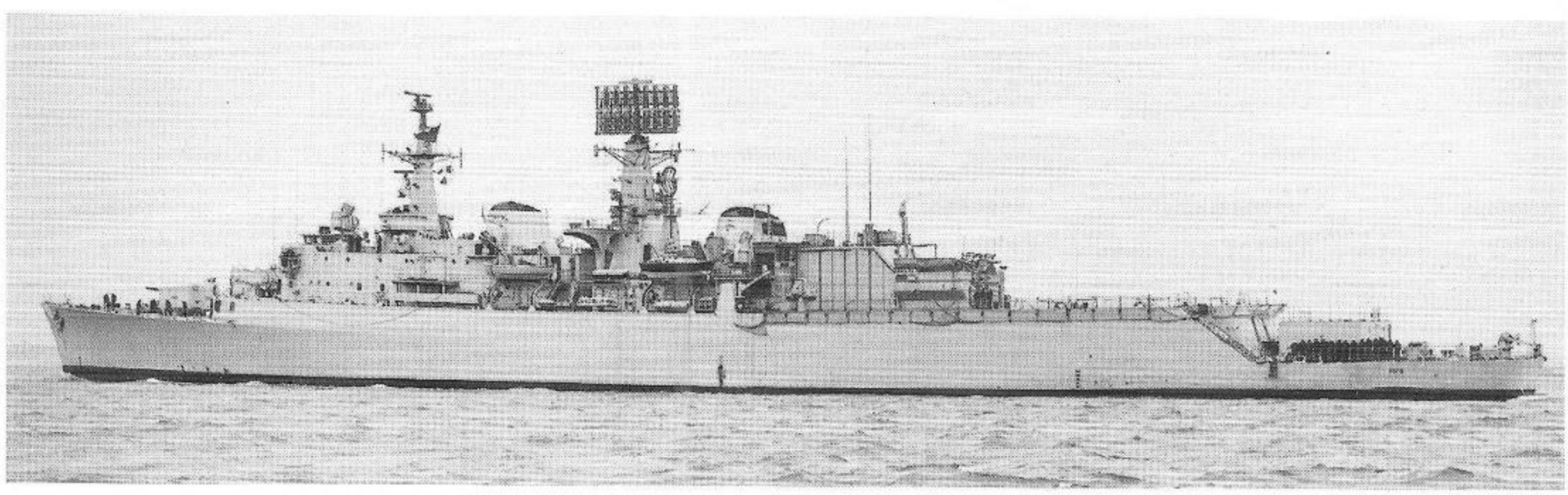
Purchased: 4
Active: 4

Displacement:
standard: 5,400 t
full load: 6,200 t

Dimensions
Length: 158.7 m (520.5 ft)
Beam: 16.5 m 54.0 ft()
Draught: 6.3 m (20.5 ft)

Speed: 30 kts
Range: 3,500 n miles at 28 kts

Complement: 470 (36 officers)



Blanco Encalada *(15) as taken over by the Chilean Navy with small helicopter deck, small hangar and Sea Slug SAM system* (H & L van Ginderen Collection)

SHIPS

PRAT (11) (ex-HMS *Norfolk*)

Builder	Swan Hunter, Wallsend, UK
Laid down	15 Mar 1966
Launched	16 Nov 1967
Commissioned (RN)	7 Mar 1970
Transferred (Chile)	6 Apr 1982

COCHRANE (12) (ex-HMS *Antrim*)

Builder	Fairfield SB & Eng Co Ltd, Govan, UK
Laid down	20 Jan 1966
Launched	19 Oct 1967
Commissioned (RN)	14 Jul 1970
Transferred (Chile)	22 Jun 1984

LATORRE (14) (ex-HMS *Glamorgan*)

Builder	Vickers (Shipbuilding) Ltd, Newcastle-upon-Tyne, UK
Laid down	13 Sep 1962
Launched	9 Jul 1964
Commissioned (RN)	11 Oct 1966
Transferred (Chile)	3 Oct 1986

BLANCO ENCALADA (15) (ex-HMS *Fife*)

Builder	Fairfield SB & Eng Co Ltd, Govan, UK
Laid down	1 Jun 1962
Launched	9 Jul 1964
Commissioned (RN)	21 Jun 1966
Transferred (Chile)	12 Aug 1987

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Exocet MM 40 anti-ship missiles

All four destroyers are armed with four MM 40 Exocet ('Flying Fish') anti-ship missiles, which have replaced the MM 38 version, previously used. The missile launch canisters are mounted before the bridge in the position formerly occupied by the 'B' 114 mm gun mounting. MM 40 is a surface-launched missile with folding wings and rocket boosters and sustainer. The missiles are carried in individual glass fibre launcher-containers, which are mounted at an angle of +12°, within which they are suspended from a launch rail in the ceiling.

There are two versions of MM 40, designated Blocks 1 and 2. Block 2 missiles feature a new J-band (10 to 20 GHz) seeker with improved ECCM performance, associated electronics and a new guidance computer, although no further details are currently available. The new electronics permit the missile to optimise its sea-skimming height, allowing it to operate in conditions to Sea State 7 even in severe ECM conditions. The fire-control system has also been adapted with the development of the Cat-Visac console which can operate with two types of the Exocet missile simultaneously. The new fire-control system allows improved target selectivity, attacks upon multiple targets by diverging and converging salvos.

Targets for the missiles are acquired by the ship's sensors, and the operator then aligns the axial gyros in the target's direction and begins the initiation sequence which can take up to 60 seconds. Exocet has a 105° off-axis engagement envelope and can perform one 15° change in the course of its flight. Once the missile has cleared the launcher-container, the sustainer carries it into the cruise phase and it then travels towards the general location of the target at a height of about 100 m (330 ft) which is low enough to reduce the chance of detection but adequate for target acquisition. Once the target is detected, the missile descends to 9 to 15 m (30 to 50 ft) in the approach phase before descending to 8 m (26 ft) (2-5 m (6.5-16 ft) in a calm sea) for a sea-skimming terminal phase. A salvo may be fired in 12 to 20 seconds.

Specifications

	MM 40 Block 1	MM 40 Block 2
Length	5.78 m (18.9 ft)	5.80 m (19.0 ft)
Diameter	35 cm (14 in)	35 cm (14 in)
Wing span	1.13 m (3.7 ft)	1.13 m (3.7 ft)
Weight	855 kg (1,885 lb)	870 kg (1,918 lb)
Speed	Mach 0.9	Mach 0.9
Range	2-38 n miles (4-70 km)	2-40.5 n miles (4-75 km)
Warhead	165 kg HE (364 lb) frag	165 kg HE (364 lb) frag
Fuze	delay impact/ proximity	impact/proximity
Guidance	Inertial and active radar	

Manufacturers/Contractors

Aerospatiale Missiles (prime).
Luchaire (warhead).

SURFACE-TO-AIR MISSILES (SAM)

BAe Sea Slug (GWS 1) Mk 2 area defence system

Sea Slug is a first-generation naval SAM, which only served in British 'County' class destroyers and now remains in service only in two of the four Chilean 'Prat' class ships. The Mk 2 missile is powered by four strap-on Gosling rocket motors, which fall away after launch, and a single Deerhound sustainer motor. Standard warhead is an explosively activated expanding rod.

The missiles are stored horizontally in the magazine without their wings and the prelaunch sequence involves them being hoisted up from the magazine and then passed by stages down an 80 m long passageway running through the ship. As they move down this 'assembly line' the wings are fitted and various tests carried out until the missiles are passed through the blast doors and enter the launcher.

The launcher system is some 9 m (30 ft) long and 6 m (20 ft) high, and consists of a framework of steel tubing which contains a single missile. The launcher is adjustable in elevation and sits on a turntable.

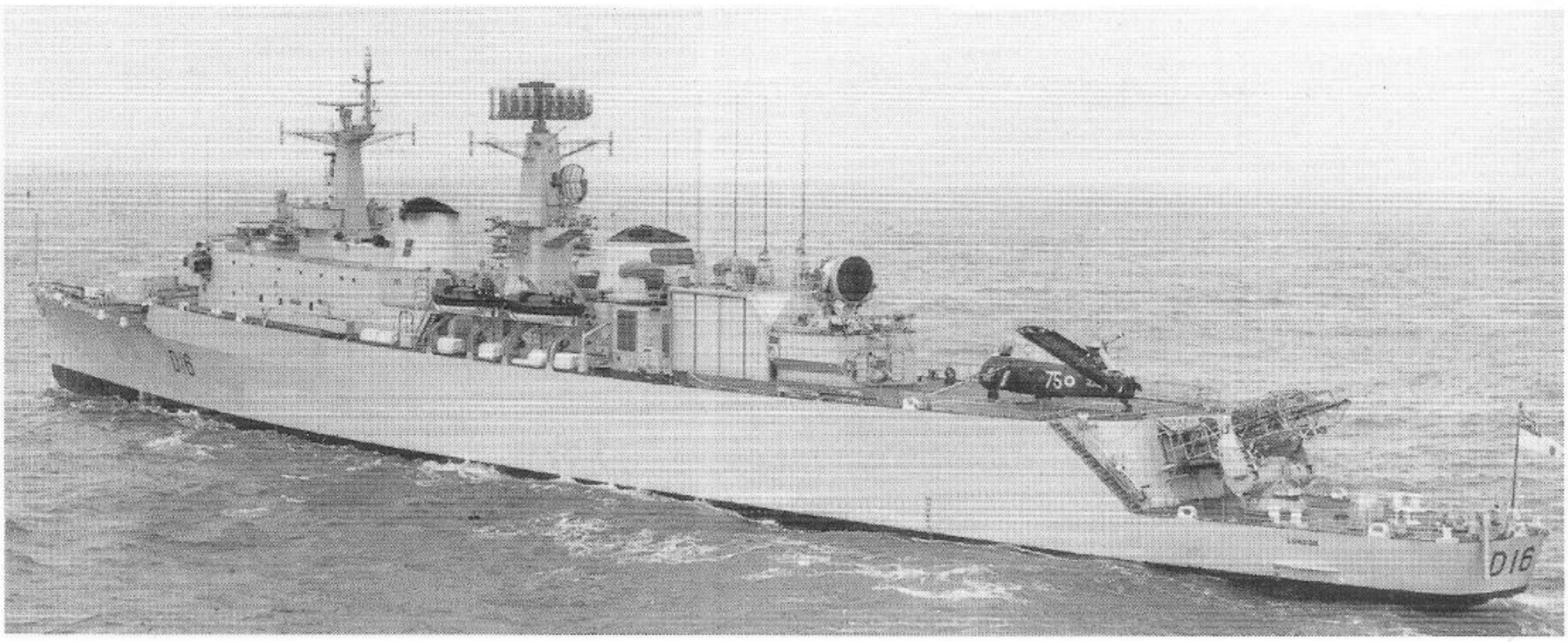
Targets are initially acquired by the prime air search radar (either Type 277, Type 965M or a Type 966) which designates the target through the SISDEF fire-control system, whose Type 901 radar is turned towards the target and separately acquires and tracks it with one antenna. The missile launcher is also turned towards the target and when the target is within range the missile is launched.

The fire-control system has a digital computer which is linked to a Type 901 pulsed, conical-scan I/J-band (8-12 GHz) radar, which features an elaborate combination of antennas and a dielectric lens to produce both acquisition and tracking beams, the acquisition phase being assisted by a pivoted antenna for vertical motion fed by an off-centre horn capable of moving along a vertical axis. During the boost phase the missile is unguided but, after the boosters have been jettisoned, it is acquired through the auxiliary gathering aerial on the director. The missile is then gathered into the guidance beam which coincides with the tracking beam and the onboard receiver is switched on so the missile may be guided to the target. Although designed primarily to deal with high-altitude missiles, and successes were reported against drones at 15,250 m (50,000 ft), Sea Slug was also designed to engage low-altitude targets and was successfully tested against them. Unlike Sea Slug Mk 1, the Mk 2 missile had an additional anti-ship capability and during the Falklands (Malvinas) war *Glamorgan* fired at least one Sea Slug against Stanley airfield.

All four ships fitted for Mk 2 Sea Slug were bought by Chile and in 1986 Chile also purchased the entire remaining stock of missiles and spare parts.

Specifications

Length: 6.10 m (20 ft)
Diameter: 0.41 m (16.1 in)
Wing span: 1.44 m (4.72 ft)
Weights:
missile: 900 kg (1,984 lb)
boosters: 915 kg (2,017 lb)
Speed: Mach 1.8



'County' class destroyer London *in British service. The Sea Slug SAM launcher on the quarterdeck was an extraordinary assembly of steel piping and girders. The launcher backed on to the magazine and missile assembly area which stretched well forward taking up almost 50 per cent of the ship's length. Note also the hangar which faced the ship's side; the helicopter had to be manhandled between the hangar and flight deck, no mean task in bad weather* (Jane's)

Blanco Encalada *(15) after modernisation at the Asmar Yard in Talcahuano, Chile. Note the extension of the flight deck to the stern and much larger hangar. Not only has the Sea Slug launcher been eliminated but much internal volume has also been released for other uses* (Chilean Navy)

Range: 21.5 n miles (40 km)
Altitude: 23,000 m (75,500 ft)
Guidance: Beam-riding

Manufacturer/Contractor
British Aerospace Defence Ltd, Dynamics Division, UK.

Barak-1 point defence system
Each ship has two Barak-1 vertical launch units (replacing the previous Sea Cat SAM launchers), each containing eight missiles which are mounted either side of the after stack. The Barak-1 point defence missile system is designed to protect ships against both manned aircraft and anti-ship missiles; it has a quick reaction time, typically 3 seconds, which includes 0.6 seconds to turnover in the anti-missile role. The Barak-1 missile is powered by a triple-thrust rocket motor, giving it a speed of approximately Mach 2.

The fire-control system is based upon the Elta EL/M-2221GM I/J- and K-band monopulse coherent tracking and illumination radar which is supplemented, on its right-hand side, by a Rafael thermal imager. The radar has a dish antenna with front feed on four 'legs', with an elevation of −25 to +85°. Search acquisition and tracking may be conducted in either I/J- (8-20 GHz) or K- (20-40 GHz) bands and it can track the target or targets while controlling two missiles. The system can also be used to control guns, possibly with the assistance of a separate ballistic computer. The Fire-Control Console (FCC) is used to control both the Barak weapon system (through the missile control unit) and also guns (through the gun control unit) and it acts as interface between the Barak weapons system and other ship systems. Upon acquisition of the target/targets by the ship's search radar the fire-control radar designates the targets and the system automatically calculates the level of threat from each target, allocates a missile or missiles and automatically launches them. In the anti-ship missile role the Barak-1 leaves the launcher vertically and is then 'turned over' towards the target by the thrust vector control system which is automatically discarded, presumably by explosive bolts, upon completion of the task. The missile is acquired and controlled by the fire-control radar which then guides it towards the target. The missile is capable of engaging targets 2 m (6.5 ft) above the sea and can manoeuvre at 25 *g*.

Specifications
Length: 2.17 m (7.12 ft)
Diameter: 17 cm (6.7 in)
Wing span: 68.4 cm (27.0 in)
Weight: 97.9 kg (216 lb)
Speed: Mach 2 (580 m/s (1,900 ft/s)
Range:
aircraft: 0.27 n miles to 6.5 n miles (500 m to 12 km)
missiles: approximately 5 km
Guidance: Command/line of sight (CLOS) or optical
Warhead: 22 kg HE fragmentation

Manufacturers/Contractors
Israel Aircraft Industries (IAI), Ben Gurion International Airport, Israel (prime).
Rafael, Haifa, Israel (launch unit).

TUBES

Six 324 mm US Mk 32 (two triple) torpedo tubes.

Specifications
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

Manufacturer/Contractor
GEC-Marconi Naval Systems, UK.

TORPEDOES

Honeywell Mk 44 Mod 1 324 mm torpedoes

Specifications
Length: 2.56 m (8.4 ft)
Diameter: 324 mm (12.75 in)
Weight: 233 kg (514 lb)
Warhead: 34 kg (75 lb) HE

Propulsion
Speed: 30 kts
Range: 3 n miles (5.5 km)
Homing: Active acoustic homing
Max depth: 300 m (984 ft) (approx)

GUNS

Vickers 114 mm (4.5 in) Mk 6 semi-automatic gun
Each of the Chilean ships has a single turret in 'A' position, mounting twin QF Mk V guns. The gun weighs 2,859 kg, has an autofretted loose barrel, jacket, removable breech ring and sealing collar, but has neither muzzle brake nor fume extractor. The barrel is 45 calibres long and has 32 grooves with a uniform 1 in 25 twist and a life of approximately 750 EFC (Equivalent Full Charges). There is a hydraulically operated vertical sliding breech block and the gun fires separate ammunition. The recoil and run-out cylinders are incorporated in the breech ring so that the total weight of the weapon is 3,368 kg. The electrohydraulically powered turret (RP 41 Mk 6) incorporates two Mk V guns and hydraulic rammers. Each gun has a separate shell and cartridge hoist, which are served by 17 men below decks.

Specifications
Mk V gun
Calibre: 114 mm
Length of barrel: 45 calibres
Muzzle velocity: 746 m/s (2,448 ft/s)
Weight of round: 25.5 kg (56 lb) (projectile only)
Range:
anti-surface: 10.25 n miles (19 km)
anti-air: 12,500 m (41,000 ft)
Rate of fire: 14 rds/min (Mk V gun)

Mountings (Mk 6)
Weight: 45 t
Traverse: 360°
Elevation: 0 to +89°
Crew: 20

Manufacturer/Contractor
Vickers Shipbuilding and Engineering Ltd, Barrow-in-Furness, Cumbria, UK.

Oerlikon 20 mm Mk 9 in Mk 7 mounts
There are either two or four Oerlikon 20 mm cannon mounts, either side of the foremast.

Specifications
Calibre: 85 mm
Muzzle velocity: 1,050-1,150 m/s (3,445-3,773 ft/s)
Range:
anti-surface: 0.92 n miles (1.7 km)
anti-air: 5,570 ft (1,700 m)
Rate of fire: 900 rds/min
Weight of round: 320-345 g
Weight of projectile: 110-125 g
Max elevation: 55°
Machine-guns: 12.7 mm (single or twin) MGs

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES

UA-8/UA-9
These destroyers are fitted with two passive radar intercept systems: UA-8 covering the frequency band 2.4-4.1 GHz; and UA-9 (7-11.5 GHz). Both are elderly British, analogue, manually operated equipments.

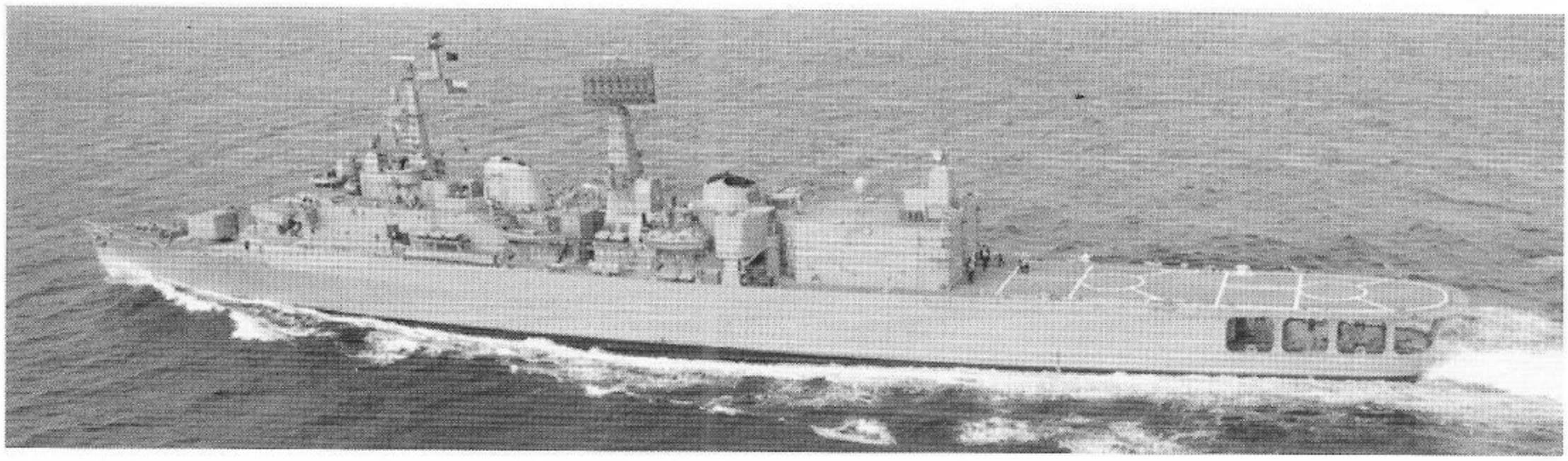
Manufacturer/Contractor
MEL.

Elta IR sensor
It is reported that an Elta IR sensor has been fitted.

Jammer
An unknown type of jammer is fitted.

DECOYS

ML Aviation Barricade countermeasures system
Barricade (British Navy designation = Outfit DLK) provides ships with means of deploying chaff and infra-red (IR) decoys to counter missile attacks, using a layered defence against the various types of anti-ship missile.



Blanco Encalada *after latest modifications. Note addition of Barak SAM launcher (oblong device at forward end of hangar) and EL/M-2221GM directors on hangar and bridge roofs. Note also the Satcom antenna on the hangar roof and the new extension arm at the head of the foremast which appears to be for new ECM/ESM equipment* (Chilean Navy)

The system uses a 57 mm rocket with a 900 rpm spin, which combines stabilisation with rapid chaff blooming. There are two types of rocket: Stockade — long range; and Pallisade — short range. The system is integrated into the tactical data handling and command/weapon control system's electronic warfare suite.

The Chilean ships have two launchers (port and starboard), each consisting of six sets of triple cells, the outer three sets being angled 60° from the next in bearing so that the launchers provide all-round coverage. The inner three sets are preset to point to the same bearing, as required, but in different elevations. The inner three sets fire short-range Pallisade rockets in centroid mode, while the outer barrels fire medium- and long-range Stockade rockets in dump, distraction and confusion modes.

There are four decoy modes:

confusion, in which long-range (Stockade) rockets are fired to confuse enemy search radar and make target selection difficult

distraction, in which medium-range chaff and/or infra-red rockets are fired in a pattern of six around the ship to present alternative targets to missiles during their search phase, affording defence against multiple missiles coming from different directions

dump is used where a missile has locked on to the ship. The ship uses a jammer to remove the missile's range gate and then fires a single rocket to produce a chaff cloud on which the gate may be 'dumped' on a suitably placed chaff cloud, thus allowing the jammer to be redeployed.

centroid, is a close-range, final defence mode, used against single missiles. If the incoming missile is locked on to the ship, a pattern of short-range chaff and/or IR rockets is fired to create a large alternative target close to the ship, which manoeuvres away, leaving the missile to home on to the decoy.

Specifications

Stockade
Dimensions: 375 × 57 mm
Weight: 1.89 kg (4.2 lb) (chaff); 1.77 kg (3.9 lb) (IR)
Payload: 0.4 kg (0.88 lb)
Range: 400-2,000 m (1,312-6,562 ft) at 30°
Rocket burn: 0.6 s
Recommended range:
confusion mode: 2,000 m (6,562 ft)
dilution mode: 800 m (2,625 ft)
Chaff frequency range: 2-20 GHz
IR payload: 550 W/steradian in 8-13 µm band

Pallisade
Dimensions: 360 × 57 mm (14 × 2.25 in)
Weight: 2.1 kg (4.63 lb)
Payload: 0.6 kg (1.3 lb)
Rocket burn: 0.6 s
Chaff frequency coverage: 8-35 GHz
IR payload: 3-14 µm band for 20 s

Manufacturer/Contractor

ML Wallop Defence Systems, Andover, Hampshire, UK.

Corvus chaff dispensing system

Corvus is a quick reaction, self-defence system firing chaff dispensing rockets to form a radar decoy screen around the vessel. The system comprises: two multibarrelled rocket launchers, launcher control and firing panel, and the 'window' dispensing rockets themselves. There are two modes of operation: distraction decoy; and centroid decoy. A cylindrical rotating structure carries eight launching tubes mounted in two sets of three, one above the other, and crossed at 90° in azimuth with two further tubes set above, and aligned midway between the other tubes, all at a fixed elevation of 30°. The maximum loading of 16 'window' rockets provides protection against three missile attacks, before reloading. The normal limits of the training arc for the launcher are between 60 and 120° but as the lower sets of rocket barrels are angled about the centreline of the rotating structure, the arc covered by the rockets is considerably greater.

Specifications

Training
Bearing arc (normal) ie launcher axis: 60-120°
Bearing arc (max) ie tube axis: 15-165°
Tube diameter: 195 mm
Tube length: 1.6 m (5.25 ft)
Weight (empty): 25 kg (55 lb)
No of guides: 4, RH spiral

Manufacturer/Contractor

Vickers Shipbuilding and Engineering Ltd, Barrow-in-Furness, Cumbria, UK.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

SISDEF SP 100 command and weapon control system

The original British ADAWS-1 system has been replaced by the SISDEF *(Sistemas de Defensa)* SP100 command and weapon control system, which is a distributed architecture system based upon the 32-bit Intel 80486DX2-66 and the TMS34020 processors, with the 8-bit Zilog Z80 being used for some interfaces. It uses Ada in all software applications, works to MIL-STD-2167A and uses commercial off-the-shelf (COTS) hardware wherever possible. The basic hardware consists of Consolas Tacticas (CONTAC) with a typical destroyer/frigate system having three vertical and two horizontal units. A console has four Intel 80486 microprocessors including one for interface purposes, one for MMI and a graphics engine. Up to 512 tracks can be displayed and a similar number of ESM bearings while the console can interface with two datalink channels. The system has tactical preprocessors to link each sensor to the Ethernet-standard local area network, an environmental preprocessor to interface with the sensors such as log, wind indicator and gyrocompass, and weapons preprocessors to link with each weapon system. Peripherals such as plotter and printer have their own computer linked as does the datalink system.

Manufacturer/Contractor

Sisdef Ltda, Vinha del Mar, Chile.

British 'County' class (Glamorgan) *in its original state, with two twin 114 mm turrets forward. Note also the foremast extension with ESM/ECM antennas which was later removed in British service but has now been replaced in Chilean service. The massive size of Type 965 'mattress' antenna is also very apparent (MoD UK)*

COMMUNICATIONS AND DATALINKS

In addition to the normal warship communications systems, all four ships are fitted with Satcom terminals

SONARS

Kelvin Hughes Type 162 M

The British Kelvin Hughes Type 162 ('Cockchafer') side-looking target detection sonar is designed to detect and classify seabed targets, such as a bottomed submarine. There are three transducers: one faces downwards at 25° below the horizontal, while the other two face sideways to cover a 3° wide and 40° vertical sector. The transmitter delivers 40 W to the central, downward-looking transducer and 80 W each to the side-looking transducers. The set operates at 50 kHz and range scales are 270 m (300 yd), 550 m (600 yd) and 1,100 m (1,200 yd)

Manufacturer/Contractor
Kelvin Hughes.

Type 184 M sonar

The Type 184 M is a British active/passive search and attack sonar system, using a circular 32-stave transducer array 1 m (3.3 ft) in diameter and 1 m high in a retractable, keel-mounted dome. It operates at 6, 7.5 and 9 kHz with pulse lengths of 45 ms and 75 ms.

Manufacturer/Contractor
Graseby Marine (Graseby Dynamics Ltd), Watford, UK.

RADARS

Set	Type 965M	Type 277M/Q	Type 992Q/R	LM 2228 S	Type 978 *	Type 903	Type 901 (11 and 14)	Two Elta EL/M-2221GM
Ships	14, 15	11, 14	All	All	All	All	11, 14	All
Company	GEC-Marconi	GEC-Marconi	GEC-Marconi	Elta	Decca	Plessey	GEC-Marconi	Elta
Role	Air search	Height finder	Short range, air target designator	Air search	Navigation	Guns	Fire control for Sea Slug	Fire control for Barak
Band	A	E	I	E/F	I	I	G/H	I/J/K
Range	100+ n miles against 20 m^2 target	–	–	–	–	–	–	–
Beam	12 × 40°	4.5 × 2°	1.25 × 15°	–	1.2°	2°	0.9°	–
Peak power	450 kW	500 kW	2 MW	–	20 kW	–	750 kW	–
Gain	20 dB		30 dB	–	–	–	24 dB	–
Pulsewidth	3.8/10 µs	0.7/1.5 µs	2.0 µs	–	0.1/1 µs	0.1 µs	0.2/0.3 µs	–
PRF	400/200 pps	500 pps	750 pps	–	1,000/500 pps	3,000 pps	1,840 pps	–
Scan rate	8 or 10 rpm	7.5 rpm	–	–	24 rpm	–	–	–

Notes
* Some may have Type 1006 instead
2. Two Plessey Type 904 (not in 14 or 15) are being removed from remainder as Sea Cat SAM system is replaced by Barak

AVIATION

AVIATION FACILITIES

Blanco Encalada and *Cochrane* both have a long flight deck and a rebuilt hangar.

Specifications

Flight deck
Area: 617 m^2 (6,642 sq ft)
Length: 37.4 m (122.7 ft)
Width: 16.5 m (54.13 ft)

Hangar
Length: 16.9 m (55.45 ft)
Width: 11.7 m (38.38 ft)

HELICOPTERS

1 Bell 206B (11 and 14). 2 NAS 332SC Super Puma (12 and 15).

Nurtanio Eurocopter NAS 332SC Cougar

Blanco Encalada and *Cochrane* both embark two twin-turbine, Nurtanio NAS 332SC multirole helicopters.

Specifications

Main rotor diameter: 15.60 m (51.18 ft)
Tail rotor diameter: 3.05 m (10.0 ft)
Length, overall, rotors turning: 18.70 m (61.35 ft)
Width, blades folded: 3.79 m (12.43 ft)
Height, overall: 4.92 m (16.14 ft)
Weights:
empty: 4,460 kg (9,832 lb)
max take-off: 8,600 kg (18,960 lb)

NAS 332C Super Puma on the flight deck of Blanco Encalada. *As sited, the helicopter is taking up less than one-third of the available space on the flight deck. Note the flying control officer's position on the edge of the flight deck* (Jane's/David Miller)

Performance (at max take-off weight)
Never-exceed speed (VNE): 150 kts (278 km/h)
Cruising speed at S/L: 144 kts (266 km/h)
Max rate of climb (sea level): 486 m (1,594 ft)/min
Service ceiling: 4,600 m (15,090 ft)
Range (sea level, standard tanks, no reserves): 470 n miles (870 km)
Power plant: 2 Turbomeca Makila 1A1 turboshafts, each with max contingency rating of 1,400 kW (1,877 shp) and max continuous rating of 1,184 kW (1,588 shp)

Blanco Encalada *after first modifications at Asmar with new flight deck and new hangar* (Chilean Navy)

Accommodation: 1 pilot (VFR)/2 pilots side by side (IFR) on flight deck, max accommodation for 24 passengers
Equipment: Optional fixed or retractable rescue hoist (capacity 275 kg; 606 lb) starboard side; equipment for naval missions can include sonar, MAD and sonobuoys
Armament: 2 AM 39 Exocet missiles or 2 lightweight torpedoes, plus 2—20 mm guns or • 2—7.62 mm machine guns

Bell Model 206 Jet Ranger

Prat and *Latorre* both carry a single Bell 206B Jet-Ranger helicopter for liaison and limited ASW duties

Specifications

Main rotor diameter: 10.16 m (33.3 ft)
Tail rotor diameter: 1.65 m (5.41 ft)
Fuselage length (rotors turning): 11.82 m (38.78 ft)
Height: 2.91 m (9.55 ft)
Weights:
empty: 742 kg (1,635 lb)
max take-off weight: 1,451 kg (3,200 lb)
Performance:
Never-exceed speed (VNE): 122 kts (140 km/h)
service ceiling: 4,115 m (13,500 ft)
max cruising speed (1,500 m (5,000 ft)): 116 kts (134 km/h)
range: 404 n miles (748 km)
Max rate of climb at sea level: 384 m (1,260 ft)/min
Power plant: 1 Allison 250-C20J flat-rated at 236 kW (317 shp)
Crew: 2, pilot, co-pilot
Sensors: None
Typical weapons loads: 1 Mk 44 torpedo or depth bomb

PROPULSION

Specifications

System: Combined steam and gas turbine (COSAG)
Boilers: 2 Babcock & Wilcox; 49.2 kg/cm² (700 psi); 510°C (950°F)
Steam turbines: 2 AEI; 22.4 MW (30,000 hp)
Gas turbines: 4 English Electric G6; 22.4 MW (30,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The original British 'County' class comprised eight ships, constructed between 1959 and 1970. They were larger than many wartime cruisers, but were ordered as 'destroyers' although they were later redesignated 'destroyer leader, guided missile' (DLG). This placed them on a par with US Navy ships such as the 'Leahy' class, but, ironically, the US Navy then designated the Leahys 'cruisers,' but this time the British did not follow their lead.

The eight ships were effectively divided into two sub-groups, with *Hampshire, Devonshire, Kent* and *London* forming the first group and the other four the second, which had the Mk 2 Sea Slug.

The eight ships served with the British Navy from 1962/70 to early 1980s. Several served in the Falklands war of which one, *Glamorgan,* was hit by an Exocet missile from a land-based launcher. The ship, having detected the incoming missile managed to turn away and the missile struck the port side abreast the hangar, destroying a Sea Cat launcher and its guidance radar and starting a fire. The fire was, however, quickly brought under control and the ship never became non-operational.

NAMES

All four ships are named after distinguished former officers of the Chilean Navy. The ranks of the officers concerned are not, however, used.

DESIGN

The principal weapons system was the Sea Slug, beam-riding SAM, which was somewhat bulky, primarily due to its wraparound booster rockets. Preparation of a missile for firing demanded a long assembly line (almost 50 per cent of the ship's total length), where components were checked; wings, control surfaces and boosters fitted; and final check carried out. The missile was then run out onto the large, box-like launcher, whose mass of struts and braces was necessitated by the wraparound boosters. The launcher held two missiles and was mounted on the quarterdeck. These procedures resulted in a long ship.

An additional factor is that the ships were 'single-ended' with only one launcher and only one Type 901 fire-control radar.

As completed, these ships had two twin 115 mm (4.5 in) mountings forward. B turret was, however, removed in four ships and replaced by four MM 38 Exocet missile launch tubes.

The ships had a flight deck above the Sea Slug magazine for a single Wessex helicopter. The hangar was rather cramped and did not access directly onto the flight deck. As a result, the aircraft had to be wheeled forward, turned through 90° and then pushed into the hangar; a singularly cumbersome procedure.

British Disposals

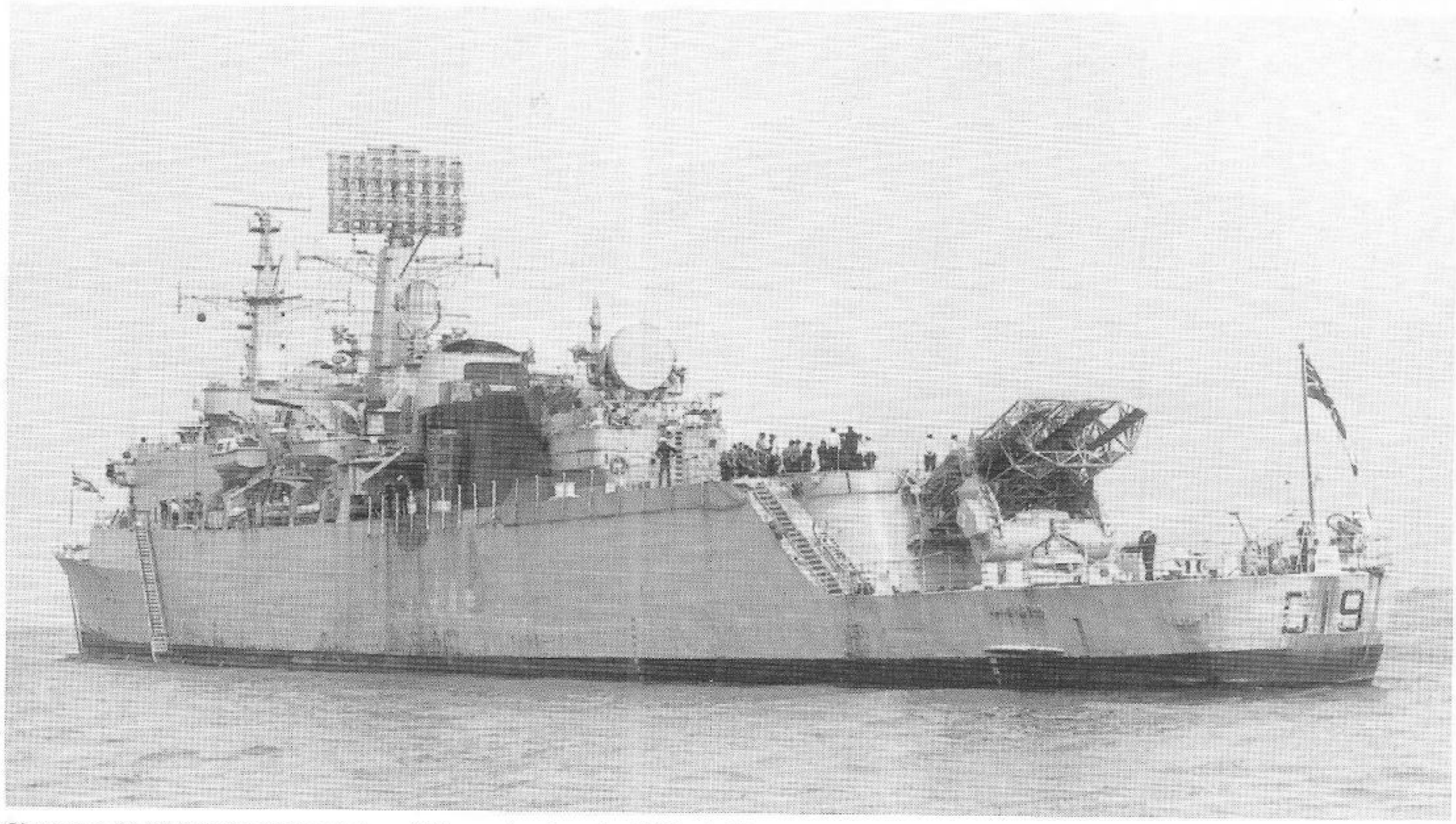
The Sea Slug was quickly outdated and the ships were particularly demanding in manpower (471 per ship) at a time when the British Navy was finding it particularly difficult to man all its ships. As a result, two were disposed of (*Hampshire* to the breakers in 1979; *Devonshire* sunk as a target in 1984) and the remainder sold. *London* went to Pakistan as *Babur* in 1982 (scrapped in 1994), while the remainder were sold to Chile.

MODERNISATION

The Chilean Navy received the former 'County' class ships over a five-year period: *Prat* in 1982, *Cochrane* in 1984, *Latorre* in 1986 and *Blanco Encalada* in 1987. *Latorre* (formerly *Glamorgan*) was not fitted with Sea Cat missile launchers at the time of transfer, as one launcher had been destroyed in the Falklands War, and the other was later removed, with both then being replaced by 40 mm guns. All four ships have been substantially rebuilt and totally refurbished at the Asmar Yard at Talcahuano, and are now divided into two two-ship groups.

Prat (11) and *Latorre* (14) are essentially unchanged from British service and retain their Sea Slug launchers, the only ships in any navy now to be armed with these missiles. These two ships serve as Flagships and there are no known plans to remove Sea Slug from them.

The other two ships have been converted at the ASMAR yard at Talcahuano, Chile, into helicopter carriers: *Blanco Encalada* was completed May 1988 and *Cochrane* in May 1994. These two ships are now markedly different in appearance from their two half-sisters, having been fitted with a greatly enlarged flight deck (617 m²), which continues right aft to accommodate two large helicopters simultaneously, making them

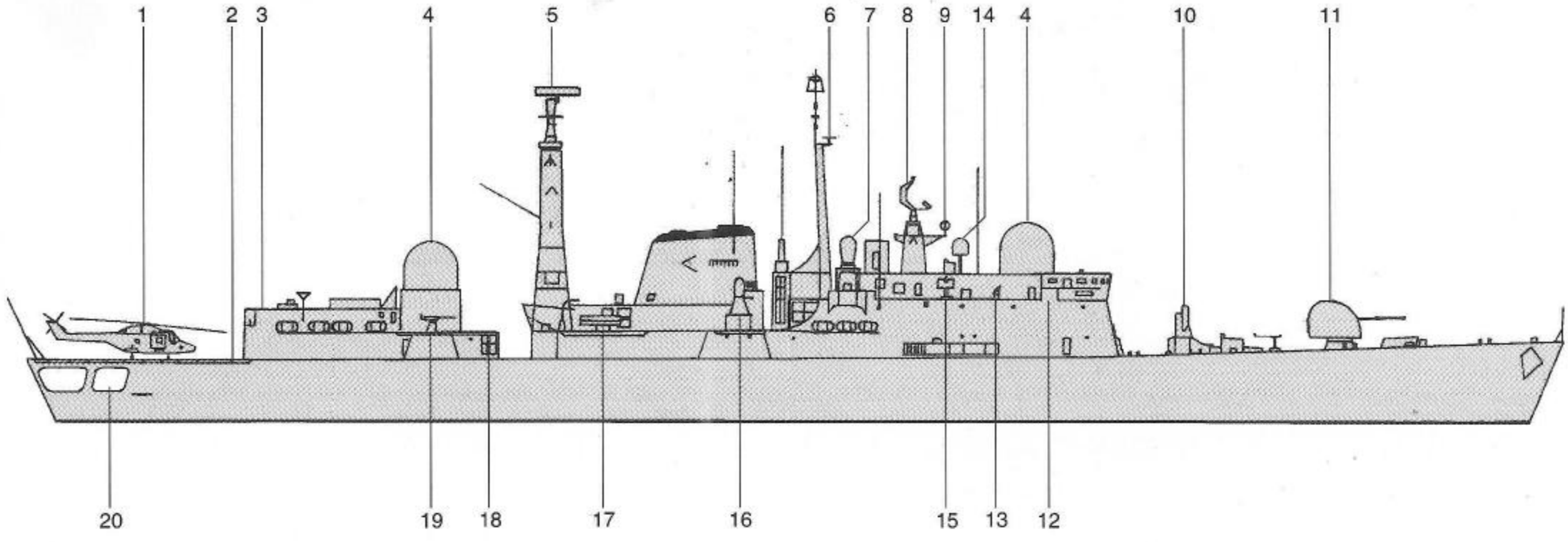


Glamorgan *(D 19) (now the Chilean* Latorre *(14)) on return from the Falklands. The large black hole shows where the Argentine Exocet missile hit, but with no effect on the ships overall operational effectiveness*

effectively flush-decked. The hangar has also been completely rebuilt and enlarged (dimensions 16.9 × 11.7 m), with the doors now opening directly onto the flight deck. The foremast has also been extended and remodelled. One of the consequences of removing Sea Slug is that a large amount of space occupied by the missile assembly bays has been made available, which has been used for such purposes as greatly enhanced damage-control facilities.

All of the class are being fitted with the Israeli Barak I SAM system in place of the outdated Sea Cat system and have a new SISDEF command system in place of ADAWS. In the future, new communications, optronic directors and ECM equipment may be fitted and VDS sonars and torpedo decoys are also possibilities.

TYPE 42 BATCHES 1 and 2



Type 42 (Ian Sturton)
1 *Westland Lynx HMA Mk 8* **2** *Flight deck* **3** *Hangar* **4** *Type 909 fire control (Sea Dart SAM system)* **5** *Type 996 radar (air/surface search)* **6** *Type 1006 radar (navigation)* **7** *SCOT Satcom antenna* **8** *Type 1002 radar (air/surface search)* **9** *DF antenna* **10** *Sea Dart twin-arm launcher* **11** *114 mm (4.5 in) gun Mk 8* **12** *Radamec 1000 N electro-optic director* **13** *Outfit DLB* **14** *Communications antenna (unidentified)* **15** *Oerlikon 20 mm cannon* **16** *Mk 15 Vulcan Phalanx CIWS* **17** *STWS Mk 3 triple 324 mm torpedo tubes* **18** *Sea Gnat decoy launchers* **19** *Oerlikon/BMARC 30 mm cannon* **20** *Type 182 torpedo decoy*

GENERAL SPECIFICATIONS

Operator: UK

Class: TYPE 42 (Batches 1 and 2)

Built: 10
Active: 8

Displacement:
standard: 3,500 t
full load: 4,100 t

Dimensions
Length: 125 m (412 ft)(overall); 119.5 m (392 ft) (wl)
Beam: 14.3 m (47 ft)
Draught: 5.8 m (19 ft) (screws)

Speed: 29 kts
Range: 4,000 n miles at 18 kts

Complement: 253 (24 officers) (accommodation for 312)

SHIPS

Batch 1

BIRMINGHAM (D 86)
Builder Cammell Laird, Birkenhead, UK
Laid down 28 Mar 1972
Launched 30 Jul 1973
Commissioned 3 Dec 1976

NEWCASTLE (D 87)
Builder Swan Hunter Shipbuilders, Wallsend-on-Tyne, UK
Laid down 21 Feb 1973
Launched 24 Apr 1975
Commissioned 23 Mar 1978

GLASGOW (D 88)
Builder Swan Hunter Shipbuilders, Wallsend-on-Tyne, UK
Laid down 16 Apr 1974
Launched 14 Apr 1976
Commissioned 24 May 1979

CARDIFF (D 108)
Builder Vickers Shipbuilding & Engineering, Barrow-in-Furness, UK
Laid down 6 Nov 1972
Launched 22 Feb 1974
Commissioned 24 Sep 1979

Batch 2

EXETER (D 89)
Builder Swan Hunter Shipbuilders, Wallsend-on-Tyne, UK
Laid down 22 Jul 1976
Launched 25 Apr 1978
Commissioned 19 Sep 1980

SOUTHAMPTON (D 90)
Builder Vosper Thornycroft, Woolston, UK
Laid down 21 Oct 1976
Launched 29 Jan 1979
Commissioned 31 Oct 1981

NOTTINGHAM (D 91)
Builder Vosper Thornycroft, Woolston, UK
Laid down 6 Feb 1978
Launched 18 Feb 1980
Commissioned 14 Apr 1983

LIVERPOOL (D 92)
Builder Cammell Laird, Birkenhead, UK
Laid down 5 Jul 1978
Launched 25 Sep 1980
Commissioned 1 Jul 1982

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

BAe Sea Dart Mod 2

There is a single, twin-arm Sea Dart launcher on the foredeck, with a magazine holding 22 rounds below. The Sea Dart missile is powered by a ramjet, with a rocket booster for launch.

Targets are initially detected by the long-range Type 1022 search radar, supplemented by the Siemens Plessey Type 996 target indication radar. The semi-automatic fire-control system, which features a Ferranti data handling system with two FM1600 computers, and Marconi display systems, evaluates target priorities, assigns a tracker and, after the missile has been launched, issues guidance commands.

The tracker-illuminator is the Marconi Type 909I (I = Improved), which is capable of only one channel of fire. Consequently, each ship has two systems to provide 360° coverage, these being housed in the prominent hemispherical radomes, one on the bridge roof, the other just abaft the mainmast.

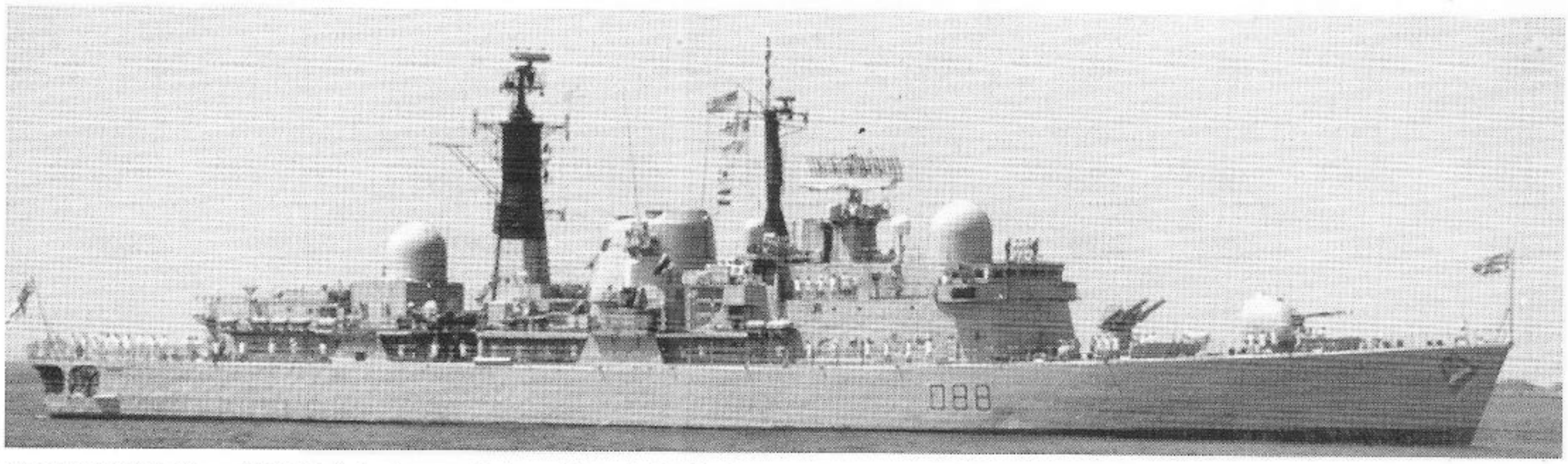
The missile handling-launching system has been designed by VSEL. The missiles are stored vertically in the magazine and are hoisted to an intermediate magazine which lies below the twin-rail launcher, from which it is separated by two flash doors. For loading, the launcher must face forward with the launch rails vertical and the flash doors then open and the missiles are raised automatically.

The targets are detected by the search/target indication radars and the data are transmitted to the fire-control system through the ship's ADAWS. Within the fire-control system the situation is evaluated and the operator selects a target and the most appropriate tracker. The fire-control computer passes target data to the tracker which locks on to the target and slews the launcher in the target's direction and then waits until the target is within range, when the missile is launched. The rocket booster takes the missile clear of the ship, accelerating it to Mach 2, at which point the ramjet ignites and the booster falls away. The missile then accelerates to Mach 3.5 and, using proportional navigation, homes on the reflected energy from the illuminator until the target is intercepted. The fire-control system then evaluates the engagement and prepares for the next one.

The system has been upgraded with the introduction of the Type 996 radar to replace the Type 992Q for target indication and improvements bring the tracker-illuminator up to Type 909I standard. The missile itself is receiving a blast fragmentation warhead with infra-red fuze. These improvements will enhance the missile's performance against sea-skimming anti-ship missiles. The missile also has a limited anti-ship capability.

Specifications

Length: 4.36 m (14.3 ft)
Diameter: 42 cm (16.53 in)



Glasgow *(D 88) a Type 42 Batch 1 destroyer entering a US port with Sea Dart missiles on the GWS.30 launcher* (H & L van Ginderen Collection)

Wing span: 91 cm (35.8 in)
Weight: 550 kg (1,213 lb)
Speed: Mach 3.5
Range: 21.5 n miles (40 km)
Altitude: 100-18,500 m (300-60,000 ft)
Guidance: Semi-active radar
Booster: RO Chow rocket; 16,000 kg thrust for 3 s
Sustainer: Rolls-Royce Odin ramjet

Manufacturer/Contractor
British Aerospace.

TORPEDOES

STWS Mk 2 anti-submarine torpedo launching system
All these ships are fitted for but not with (FFBNW) two sets of triple 324 mm Plessey (Shipborne Torpedo Weapon System) STWS torpedo tubes. Each group consists of a triple-tube launcher, a launch control, and a presetter unit, which are linked to the launchers through local control panels. On the possibility of action, the launchers are manually trained to an angle of 45° using a training handle installed between the two lower tubes, but thereafter they are remotely operated. The tubes themselves are made of glass fibre-reinforced epoxide resin and mounted in a triangular configuration. STWS 2 is designed to operate with the Mk 46 and the Sting Ray lightweight torpedoes. It has electrically operated muzzle doors while the presetter/launch controller features Motorola 30800 microprocessors. It also features a strengthened mounting, better access to the tubes and improvements in the diagnostic and heater systems.

Specifications
Length: 3.65 m (11.97 ft)
Height: 1.4 m (4.60 ft)
Width: 1.23 m (4.04 ft)
Weight: 1,560 kg (3,440 lb) (unloaded)

Manufacturers/Contractors
Marconi Underwater Systems Ltd.
GEC Plessey Naval Systems.

GUNS

Vickers 114 mm (4.5 in)/55 Mk 8 multipurpose gun
The Type 42 mounts a single 114 mm (4.5 in) Mk 8 gun in A position. This gun mounting is designed to provide quick-reaction short-range air defence, to engage surface targets including fast attack craft, and to provide gunfire support to ground forces. The weapon system consists of the gun mounting, the ammunition feed system, the remote power control system, and the captain-of-turret panel.

The barrel is 6.22 m long, is fitted with a muzzle brake and fume extractor, and has a life of 3,300 rounds EFC (Equivalent Full Charge). The mounting is completely enclosed in a glass fibre shield which protects it against the environment, blast and shrapnel. The loading system is hydraulically operated, with an autoloader which is manually fed by two loaders and has a capacity of six rounds. The hoist transfers them in two stages to the turret from where they are raised by a pivoting loading arm to the breech where they are inserted by a power rammer. After the shell is fired, the case is extracted automatically and ejected through a chute in the front of the mounting.

Specifications
Calibre: 114 mm
Length of barrel: 55 calibres
Traverse: 340° at 40°/s
Elevation: −10 to +55° at 40°/s
Muzzle velocity: 868.7 m/s
Weight of projectile: 21 kg
Rate of fire: 25 rds/min
Range:
anti-surface: 11.9 n miles (22 km)
anti-air: 6,000 m (20,000 ft)
Crew: 4 (gun captain (CIC), loading supervisor, 2 loaders)

Manufacturer/Contractor
Vickers Shipbuilding and Engineering Ltd, Barrow-in-Furness, Cumbria, UK.

20 mm Oerlikon mountings
All Type 42s have four single Oerlikon 20 mm/65 cannon Model KAA guns in manually operated, open mounts. All ships have two GAM-BO1 mountings, but the remaining two mountings are either a further two GAM-BO1 or, in some cases, the earlier, simpler (and presumably cheaper) Mk 7A mounting.

The Mk 7A mounting is very simple but has a shield. The GAM-BO1 uses a swivel fork with the sidewalls having the trunnion bearings. The cradle is made of light alloy and the weapon's working parts are enclosed in a protective case whose top opens to ease maintenance and installation. The sight, shoulder rests and back support strap are all attached to the sight bracket which is adjustable for height. Usually these mountings have an optical ring sight but they can also be fitted with a lead computing sight. The ammunition box with 200 rounds is attached to the front of the mounting and the belt is fed from the right side of the gun, with spent cartridge cases being ejected between the sidewalls of the cradle into a separate compartment, while the links are collected in a bag on the other side of the mounting.

Newcastle *(D 87) in the English Channel. Note the Vulcan Phalanx CIWS, readily identified by its white thimble radome. These Type 42s are due to be replaced by Project Horizon air defence frigates but if Horizon is late, as now appears very probable, the Type 42s will need major, and very costly refits*

Specifications

Mounting	GAM-BO1	Mk 7A
Elevation	55°	50°
Gun Model	KAA	Mk 2
Calibre	20 mm	20 mm
Length of barrel	85 cal	70 cal
Effective range surface target aircraft	 2,500 m (2,700 yd) 1,200 m (1,300 yd)	 1,500 m (1,650 yd) 1,150 m (1,250 yd)
Rate of fire	1,000 rds/min	800 rds/min
Round weight	320-345 g	241 g
Projectile	110-125 g	122 g

Manufacturers/Contractors

Royal Ordnance, Medium Calibre Gun Division (mounting).
Oerlikon Contraves AG, Defence (cannon).

Hughes Mk 15 CIWS Phalanx

Two Hughes Mk 15 Phalanx close in weapons systems (CIWS) provide the innermost layer of defence against anti-ship missiles and consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n miles (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications

Gun
Calibre: 20 mm
Length of barrel: 53 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)

Mounting
Weight: 5.42 t (Block 0), 6.18 t (Block 1)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse-Doppler

Manufacturers/Contractors

General Dynamics (system).
General Electric (gun).
Lockheed Electronics (radar).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Racal Outfit UAA-2

Outfit UAA-2 (also known as 'Abbey Hill') is a solid-state development of Outfit UAA-1, which is a passive reception, signal analysis and direction-finding system, using IFM receivers. Frequency range has not been published but is believed to be in the 1 to 18 GHz range. The intercept and DF antenna is a series of radome-covered horns normally mounted under the masthead radar. Accuracy of measurement is reported to be 1.5 MHz in frequency and 3° in bearing. There is also a threat identification system. The UAA-2 upgrade features solid-state electronics in the system front end, an improved threat library and an increase in the number of warner channels.

Manufacturer/Contractor

Racal Radar Defence Systems Ltd, Chessington, Surrey, UK.

ELECTRONIC COUNTERMEASURES (ECM)

Type 670

Type 670 is an ECM system installed in Batch 1 ships; it has the codename 'Heather'. It is a somewhat elderly equipment and the fact that Batch 1 ships are fitted with the more up-to-date Type 675 for particular missions suggests that it may not be capable of dealing with the latest threats.

THORN EMI Type 675 radar detection and jamming system

Type 675 is installed in all Batch 2 ships, where it replaces Type 670, and it is believed that containerised Type 675 has also been installed in Batch 1 ships for particular missions; (for example, Gulf deployments) and removed on return. Type 675 is an active/passive EW system designed to counter a wide range of operational threats, particularly those of radar-guided missiles. The system counters and confuses surveillance and missile homing radars by the use of selective jamming techniques for both area and point defence. Azimuth coverage is 360° with an elevation cover of 50° and a detection range of up to 500 km. Two antenna mounts, both with mechanical steering to give full azimuth and elevation coverage, ensure uninterrupted all-round view. Each mount carries a direction-finding receiving antenna together with transmit antennas. Received signals are analysed to identify those which may pose a threat and the selected signals are processed to allow generation of the jamming signal.

High-power transmitter subsystems, matched to the antenna, provide jamming capability against several types of target simultaneously. A comprehensive ECM library stores the appropriate countermeasures to a range of potential threats and, on receipt of a warning from the ESM system, the ECM processor selects the appropriate jamming mode to give fast response.

The main equipment cabinets can be situated below decks or installed in containers for mounting on the upper deck or superstructure, as has been done in a number of British ships serving in the Gulf. Such containers provide for easy removal and refit to other ships. In the British Navy the Type 675 is also known as 'Millpost' while an export variant is designated 'Guardian' by the company.

Manufacturer/Contractor

THORN EMI Electronics Ltd, Sensors Group, Crawley.

DECOYS

Outfit DLB

Outfit DLB consists of four Hunting Engineering 130 mm 'Sea Gnat' six-barrel launchers which are grouped in pairs on either side of the bridge structure. The control unit, by THORN EMI, provides for the launching of the most effective combination of rounds for distraction and centroid/seduction giving the type, speed and direction of the threat, the ship's speed and heading as well as wind direction and speed. The munitions involved are the Mk 214 RF seduction, Mk 216 RF distraction rounds, and Mk 218 IR seduction rounds.

Manufacturers/Contractors

THORN EMI/AB Precision Ltd (control unit).
Hunting Engineering (launcher).
Chemring Ltd (Munitions).

Graseby Type 182 towed torpedo decoy

The Type 182 towed torpedo decoy is designed to decoy both active and passive homing torpedoes, using signals electronically generated within the ship and fed, via the towing cable, to electroacoustic transducers within the towed body. The Type 182 produces two independently controllable output signals which are radiated simultaneously from the towed decoy. An amplitude modulated noise signal simulates the ship's propeller noise and causes passive-homing torpedoes to be seduced away from the ship towards the towed decoy. The second signal is a swept CW signal which simulates sonar echoes, in order to confuse or jam the guidance system of active homing torpedoes, thus causing them to miss the ship. The frequency bands covered by both types of output are switchable to meet tactical scenarios and to enable concurrent operation of other sonar and communication equipments.

Specifications

Towed decoy:
diameter: 533 mm (21 in)
length: 2.05 m (6.57 ft)
weight: 74 kg (163 lb)
Towing cable:
length: 411 m (1,350 ft)
diameter: 14.48 mm (0.57 in)
weight: 269 kg (593 lb)

Manufacturer/Contractor

Graseby Marine (Graseby Dynamics Ltd), Watford, UK.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

ADAWS 7 action data automation

All Batch 1 and Batch 2 ships now have ADAWS 7 action data automation system, although there is apparently a number of differences between individual ship fits. ADAWS creates a detailed picture of the air, surface and subsurface tactical situation around a task group or task force and directs responses to threats. ADAWS has a mainframe architecture based upon two Ferranti FM1600 24-bit computers using Coral 66 language software. Each has a 262 k maximum memory and an operating speed of 100 Kops. The software was produced by the Defence Research Agency and Ferranti. The computers process data from ship sensors and off-ship radars (the latter via Link 11) and then present them to the display systems. A DataLink Pre-Processor (DLPP) is included to act as an interface with the Link 11 datalink.

The computers are also used to evaluate the threats from different targets and to designate them to the most appropriate weapon system. They also control the ship's weapons, providing aiming and ballistic calculation data for both missiles and the 114 mm (4.5 in)

guns. They may also be used to calculate data for controlling the operational use of both ASW helicopters and fighters. Auto-tracking of targets is available using LFX (Limited area/Full eXtraction) and LAX (Limited area Auto eXtraction) with or without auto-initiation of tracks. The system is linked to the sensors and displays by a data highway.

Manufacturers/Contractors

Ferranti International Defence Systems Integration (prime contractor, computers, software).
GEC-Marconi Naval Systems/GEC-Marconi Combat Systems (displays, interface, drive equipment).

COMMUNICATIONS AND DATALINKS

Two Matra-Marconi SCOT 1C Satcoms
Link 10
Link 11
Link 14
Marisat
Link 16 (in due course)
FLTSATCOM

WEAPONS CONTROL

GWS.30 Mod 2

The Sea Dart missile is part of GWS.30 (Guided Weapon System), which is composed of a number of elements. The tracker-illuminator is the Marconi Radar Systems Type 909, a G/H-band system with a 2.44 m cassegrain antenna in a cupola assembly. The radar head and radar cabin, with its transmitter/receiver and supporting electronics are produced as a single prefabricated assembly to assist functional testing as well as reducing installation and replacement times. The Type 909I (I = improved) has an enhanced transmitter and signal processor. Both systems are, however, capable of only one channel of fire and consequently each ship has two systems to provide 360° coverage. Targets are initially detected by the long-range search radar (Marconi Type 1022), supplemented by the target indication radar (Siemens Plessey Type 996). The Type 1022 is a D-band radar with a squintless-feed antenna to provide good sidelobe performance. It has a synthesiser-driven TWT transmitter by Signaal, pulse-to-pulse coherence and a pulse-compression receiver with MTI. The Type 996 is also an E/F-band system based upon the Plessey AWS-5 with a stabilised planar array antenna and a 3D capability. The semi-automatic fire-control system features a Ferranti data handling system with two FM1600 computers, and Marconi Underwater Systems Ltd (MUSL) display systems. The system evaluates target priorities, assigns a tracker and, after the missile has been launched, it issues guidance commands. The GSA 1 system is installed as a back up.

Radamec 2100 series optronic surveillance director

There are two Radamec System 2100 electro-optical surveillance systems, each consisting of a stabilised, remotely operated, director. The director has a full sector auto-scan facility and is used for target identification. It may be integrated with display systems of the customer's choice. Sensors include the HK 202 daylight TV or HK 203 low-light TV cameras and a thermal imager. The HK 202 can detect a 10 m² target at 15 km and the HK 203 can detect it at 4 km. The thermal imager could detect such a target at 13 to 18 km.

Manufacturer/Contractor

Radamec Defence Systems Ltd.

SONARS

Ferranti-Thomson Type 2050 sonar

Type 2050 is being progressively installed in the Type 42 ships, replacing the Type 2016. The system introduces digital signal processing and distributed data processing using Ferranti Digital Signal Processing (DSP) cards and multiple Ferranti Argus M700 processors. The provision of extensive data processing facilities and improved man/machine interfaces allows one operator to control the complete system. The equipment will interface to the combat system data highway feeding data to the Ferranti CACS action information system.

Type 2050 operates at 4.5 to 7.5 kHz, using 64 5.5° beams.

The array can be installed in bow or keel domes but, in the case of the Type 42s, it is the latter.

Manufacturer/Contractor

Ferranti-Thomson Sonar Systems UK Ltd (prime system contractor), Stockport, UK (prime).

GEC-Marconi Type 2016 sonar

Type 2016 replaced the original sonars in the Type 42,

A Type 42 destoyer showing a variety of antennas. The white arrays at the foremasthead are part of the ship to ship system, with behind them the Type 996 array. Partly covered by the larger White Ensign is the Kelvin Hughes Type 1007 navigation antenna. The wide rectangular antenna is the Type 1022 air search radar with an IFF interrogator immediately above it. The large dome covers the antenna for the Type 909 fire-control radar for the Sea Wolf system which is flanked by two SCOT Satcom domes and the two white thimble radomes on the Mk 15 Vulcan Phalanx CIWS. In front of the two CIWS and on the bridge wings are two Radamec 1000N optronics directors (Jane's/H M Steele)

RADARS

Type	Type 1022	Type 996	Type 1006	Type 909I (two)
Manufactuer	Marconi/Signaal	Marconi	Kelvin Hughes	Marconi
Role	Long-range air search	Surface search	Navigation	Fire control
Band	D	E/F	I	I/J
Beam	2.2 × csc² to 40°	1.4 × 1.5°	1 × 18°/ 0.75 × 18°	
Peak power	5.2 kW (mean)	125 kW	25 kW	
Gain	30 dB	41 dB	31 dB/34 dB	
Pulsewidth	35/69 µs	low angle — 65 µs; high angle — 31.5µs	0.8 or 0.25 µs/ 0.75 µs	
PRF	1,000/5,000 pps	550-3,000 µs	1,600/800 pps	
Scan rate	7.5/15 rpm		24 rpm	
Typical range	145 n miles (265 km)		64 n miles (117 km)	

Liverpool *(D 92) a Type 42 Batch 2 destroyer. This picture is unusual because it shows the Type 909 fire directors with the glassfibre radome removed. The Outfit UAA-1 (Abbey Hill) array at the top of the black part of the mainmast also shows up very clearly* (Jane's/H M Steele)

but is now itself being replaced by the Type 2050; it remains in service, however, in some. Type 2016 is a hull-mounted panoramic surveillance and attack sonar with facilities for classification and multiple target tracking. Interference between nearby vessels using the Type 2016 sonar is largely eliminated by the use of a new type of broadband transducer. The sonar display console is designed for manning by a single operator under normal cruise conditions, who is able to initiate the preparatory actions necessary for urgent action. Digital data processing facilities are based on use of Ferranti computer equipment, with other subcontractors including Marconi Radar.

The Type 2016 roll-stabilised array has 64 staves, each with 12 elements, producing two beams; one is just below the horizontal, while the other is at 7° below horizontal to penetrate under the surface layer. Transmission frequencies are 5.5 kHz, 6.5 kHz and 7.5 kHz, and total transmitter power is 44 kW. Type 2016 is fitted in a ribless monocoque glass-reinforced plastic sonar dome on the keel, array stabilisation being either hydraulic or by electronic beam-steering.

Manufacturer/Contractor

GEC-Marconi Naval Systems Ltd, Sonar Systems Division, Templecombe, Somerset, UK (prime).

Kelvin Hughes Type 162M

The Type 162M ('Cockchafer') is a sideways-looking, target detection sonar whose main use is in detecting and classifying seabed targets, such as a bottomed submarine. There are three transducers: one faces downwards at 25° below the horizontal, while the other two face sideways to cover a 3° wide and 40° vertical sector. The transmitter delivers 40 W to the central, downward-looking transducer and 80 W each to the side-looking transducers. The set operates at 50 kHz and accuracy is <2 per cent over ranges of 270 m (300 yd) and 550 m (600 yd).

Manufacturer/Contractor

Kelvin Hughes, Watford, UK.

AVIATION

AVIATION FACILITIES

Specifications

Flight deck: 14.2 × 12.26 m (46 × 40.2 ft)
Hangar: 12.6 × 10.6 m (41.6 × 35 ft)

HELICOPTERS

1 Westland Lynx HMA Mk 8.

Specifications

Main rotor diameter: 12.80 m (42.00 ft)
Tail rotor diameter: 2.21 m (7.25 ft)
Length overall (rotors turning): 15.165 m (49.75 ft)
Weights
empty: 2,740 kg (6,040 lb)
empty, equipped (ASW): 3,343 kg (7,370 lb)
Performance:
cruising speed: 125 kts (232 km/h; 144 mph)
speed for max endurance: 70 kts (130 km/h)
max rate of climb: 661 m (2,170 ft)/min
time on station (ASW) 50 n miles (93 km) radius: 2 h
max range: 320 n miles (593 km)
max endurance: 2 h 50 m
Power plant: 2 Rolls-Royce Gem 41-1 with max contingency rating of 835 kW (1,120 shp)
Crew: 2, pilot and co-pilot/observer
Radar: GEC-Marconi ARI5979 Seaspray Mk 1 lightweight search and tracking radar
Mission: Racal MIR-2 Orange Crop passive radar detection system; CAE Electronics AN/ASQ-504(V) internal MAD, optional GEC Sandpiper FLIR
General: ASW armament includes 2 homing torpedoes, 2 Mk 11 depth charges, or 4 Sea Skua semi-active homing missiles

PROPULSION

Specifications

System: combined gas turbine or gas turbine (COGOG)
Main machinery
cruise: 2 Rolls-Royce Tyne RM1C gas turbines; 7.4 MW (9,900 hp) sustained
boost: 2 Rolls-Royce Olympus TM3B gas turbines; 37.3 MW (50,000 hp) sustained
Shafts: 2
Propellers: cp

FURTHER INFORMATION

PROGRAMME

In the early 1960s the future of the British Navy centred upon a new attack carrier (CVA-01) and four Type 82 escorts.

With the cancellation of the carrier, however, and the reduction of the Type 82 to just one ship *(Bristol)*, a new operational requirement was prepared for a smaller ship, 82, which would be capable of providing air defence cover for ASW escorts and convoys, and armed with the Sea Dart missile. The ship was also required to be smaller, and less expensive both in captial and running costs than the Type 82, and also to be able to operate as an independent unit and not necessarily as part of a task group.

The first six Type 42s (known as 'Batch 1') joined the fleet between 1976 and 1979 and was followed by a further four ships of the virtually identical Batch 2, which were commissioned between 1980 and 1982.

DESIGN

The Type 42 introduced a number of significant innovations, one of the most significant being the COGOG propulsion system. The two previous destroyer classes ('County' class and the Type 82) had combined steam and gas turbine (COSAG) propulsion systems, which were both complex and expensive. The Type 42, however, had a plant consisting of Tyne cruise engines with Olympus boost engines, with one of each type paired on each shaft, an arrangement which has proved particularly successful in service. Particular attention was paid to accessibility of equipment and removal routes, while automation resulted in major savings in manpower compared to previous classes.

The ships also have a Sea Dart system which is lighter and less complicated than that in the Type 82, although the number of reloads is considerably smaller.

Due to the limitations placed on their size during the design stage and the pressure to pack as much weaponry and equipment as possible into them, these ships are rather cramped.

MODERNISATION

During and following the Falklands (Malvinas) war numerous changes were made, particularly to the close in defence systems. US SRBOC launchers were fitted and additional guns mounted, including two single 20 mm and two twin BMARC 30 mm GCM-A02, the latter being replaced later by Mk 15 Phalanx systems.

The ships' sensor systems have been regularly updated during refits.

The ships are fitted for but not with SWS Mk 2 torpedo tubes, but these may be installed in Batch 2 ships in due course. There are, apparently, no plans to fit them in Batch 1 ships. The Radamec 1000N optronic director is fitted in *Liverpool* (D 92) for trials.

OPERATIONAL

A number of Type 42s was deployed with the British task force during the Falklands (Malvinas) war, where their Sea Darts were responsible for downing a number of Argentine aircraft. The lack of airborne early warning (AEW) aircraft aboard the carriers meant that several Type 42s had to be employed as radar pickets and it was while employed on this mission that *Sheffield* was hit on 4 May 1982 by an AM-39 Exocet missile launched by an Argentine Super Etendard. *Sheffield* was so badly damaged by fire that it sank four days later. Three weeks later, another ship of the class, *Coventry,* was hit by three bombs on 25 May and sank. *Glasgow* was hit by a single bomb, which failed to explode; the ship was later repaired and returned to service.

Southampton was serving in the Gulf when it collided with the ro-ro ship, *Tor Bay,* on 3 September 1988. The damage was so severe that it had to be returned to the UK on a dockship, where it was rebuilt and modernised at considerable cost, returning to service in 1991.

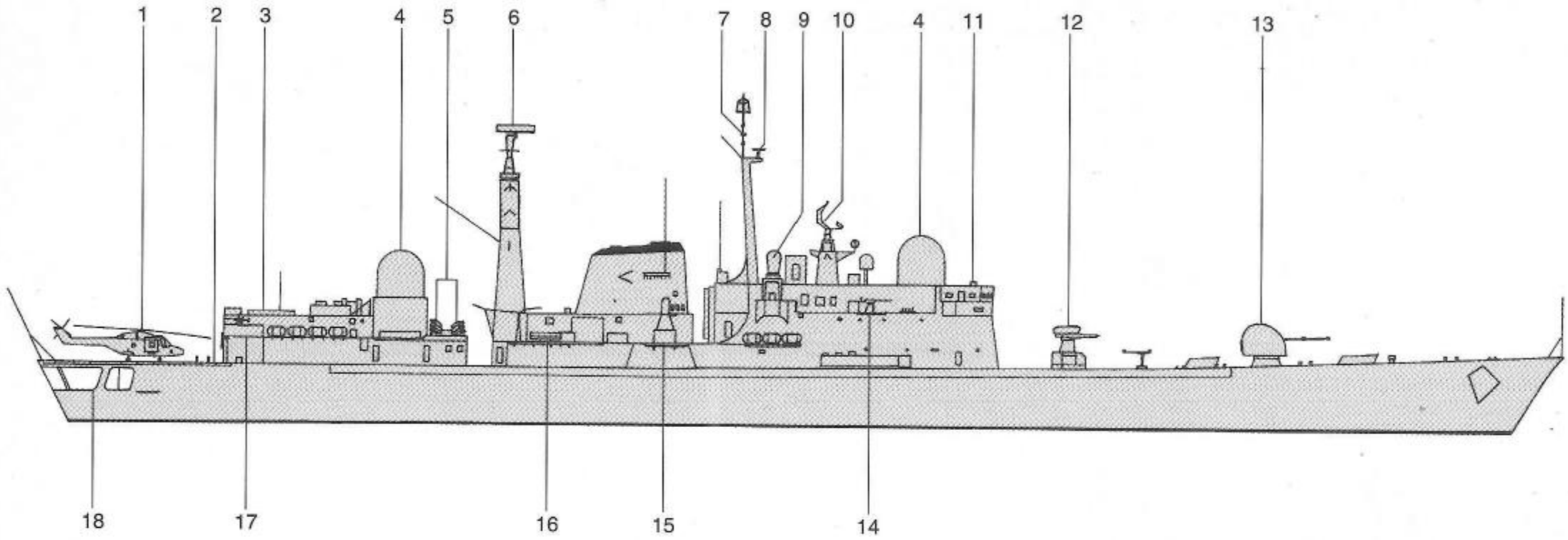
The Sea Dart GWS 30 system was used with considerable success during the Falklands (Malvinas) war, it being generally accepted that this missile can be credited with shooting down seven confirmed Argentine aircraft and one 'possible'. The confirmed kills comprised a Puma helicopter (9 May); four A-4 Skyhawks (two each on 25 and 30 May); a Learjet reconnaissance aircraft (7 June) and a Canberra bomber (13 June). Another two Argentine A-4Cs crashed on 9 May, possibly as a result of damage caused by Sea Darts. Unfortunately, a British Army Gazelle helicopter was shot down in error by a Sea Dart missile on 6 June.

THE FUTURE

The Type 42s were due to be replaced by Project Horizon frigates starting in 2002, but, as every sailor knows, the horizon is always just out of reach. The delays in the trinational programme have continually pushed back the in-service date and it is reported that the Type 42s may have to be modernised and given a major extension of operational service to cover the gap.

Exeter *(D 89) the first of the Type 42 Batch 2 ships*

TYPE 42 BATCH 3



Type 42 Batch 3 (Ian Sturton)
1 *Westland Lynx HMA Mk 8* **2** *Flight deck* **3** *Hangar* **4** *Type 909 Mod 1 fire control (Sea Dart)* **5** *Sea Gnat launchers* **6** *Type 996 radar (air/surface search) UHF communications antennas* **7** *UHF communication antennas* **8** *Type 1006 navigation radar* **9** *SCOT Satcom* **10** *Type 1002 radar (air search)* **11** *Radamec 2100 electro-optic director* **12** *Sea Dart launcher* **13** *114 mm (4.5 in) gun Mk 8* **14** *Oerlikon BMARC 20 mm cannon* **15** *Mk 15 Vulcan Phalanx 20 mm CIWS* **16** *STWS2 Mk triple 324 mm launcher* **17** *Oerlikon 20 mm Mk 7A cannon* **18** *Type 182 towed torpedo decoy*

GENERAL SPECIFICATIONS

Operator: UK

Class: TYPE 42 BATCH 3

Built: 4
Active: 4

Displacement:
standard: 3,500 t
full load: 4,675 t

Dimensions
Length: 141.1 m 462.8 ft (oa); 132.3 m (434 ft) (wl)
Beam: 14.9 m (49 ft)

Draught: 5.8 m (19 ft) (screws)

Speed: 30+ kts
Range: 4,000 n miles at 18 kts

Complement: 301 (26 officers)

SHIPS

MANCHESTER (D 95)
Builder Vickers Shipbuilding & Engineering, Barrow-in-Furness, Cumbria, UK
Laid down 19 May 1978
Launched 24 Nov 1980
Commissioned 16 Dec 1982

GLOUCESTER (D 96)
Builder Vosper Thornycroft, Woolston, Hampshire, UK
Laid down 29 Oct 1979
Launched 2 Nov 1982
Commissioned 11 Sep 1985

EDINBURGH (D 97)
Builder Cammell Laird, Birkenhead, UK
Laid down 8 Sep 1980
Launched 14 Apr 1983
Commissioned 17 Dec 1985

YORK (D 98)
Builder Swan Hunter Shipbuilders, Wallsend-on-Tyne, UK
Laid down 18 Jan 1980
Launched 21 Jun 1982
Commissioned 9 Aug 1985

WEAPONS SYSTEMS

SURFACE-TO-AIR MISSILES (SAM)

BAe Sea Dart missile system Mod 2

There is a single, twin-arm Sea Dart launcher on the foredeck, with a magazine holding 22 rounds below. The Sea Dart missile is powered by a ramjet, with a rocket booster for launch.

Targets are initially detected by the long-range Type 1022 search radar, supplemented by the Siemens Plessey Type 996 target indication radar. The semi-automatic fire-control system features a Ferranti data handling system which features two FM1600 computers and Marconi display systems, evaluates target priorities, assigns a tracker and, after the missile has been launched, issues guidance commands.

The tracker-illuminator is the Marconi Type 909I (I = Improved), which is capable of only one channel of fire. Consequently each ship has two systems to provide 360° coverage, these being housed in the prominent hemispherical radomes, one on the bridge roof, the other just abaft the mainmast.

The missile handling-launching system has been designed by VSEL. The missiles are stored vertically in the magazine and are hoisted to an intermediate magazine which lies below the twin-rail launcher, from which it is separated by two flash doors. For loading, the launcher must face forward with the launch rails vertical and the flash doors then open and the missiles are raised automatically.

The targets are detected by the search/target indication radars and the data are transmitted to the fire-control system through the ship's ADAWS. Within the fire-control system the situation is evaluated and the operator selects a target and the most appropriate tracker. The fire-control computer passes target data to the tracker which locks on to the target and slews the launcher in the target's direction and then waits until the target is within range, when the missile is launched. The rocket booster takes the missile clear of the ship, accelerating it to Mach 2, at which point the ramjet ignites and the booster falls away. The missile then accelerates to Mach 3.5 and, using proportional navigation, the missile homes on the reflected energy from the illuminator until the target is intercepted. The fire-control system then evaluates the engagement and prepares for the next one.

The system has been upgraded with the introduction of the Type 996 to replace the Type 992Q for target indication and improvements bring the tracker-illuminator up to Type 909I standard. The missile itself is receiving a blast fragmentation warhead with infra-red fuze. These improvements will enhance the missile's performance against sea-skimming anti-ship missiles. The missile also has a limited anti-ship capability.

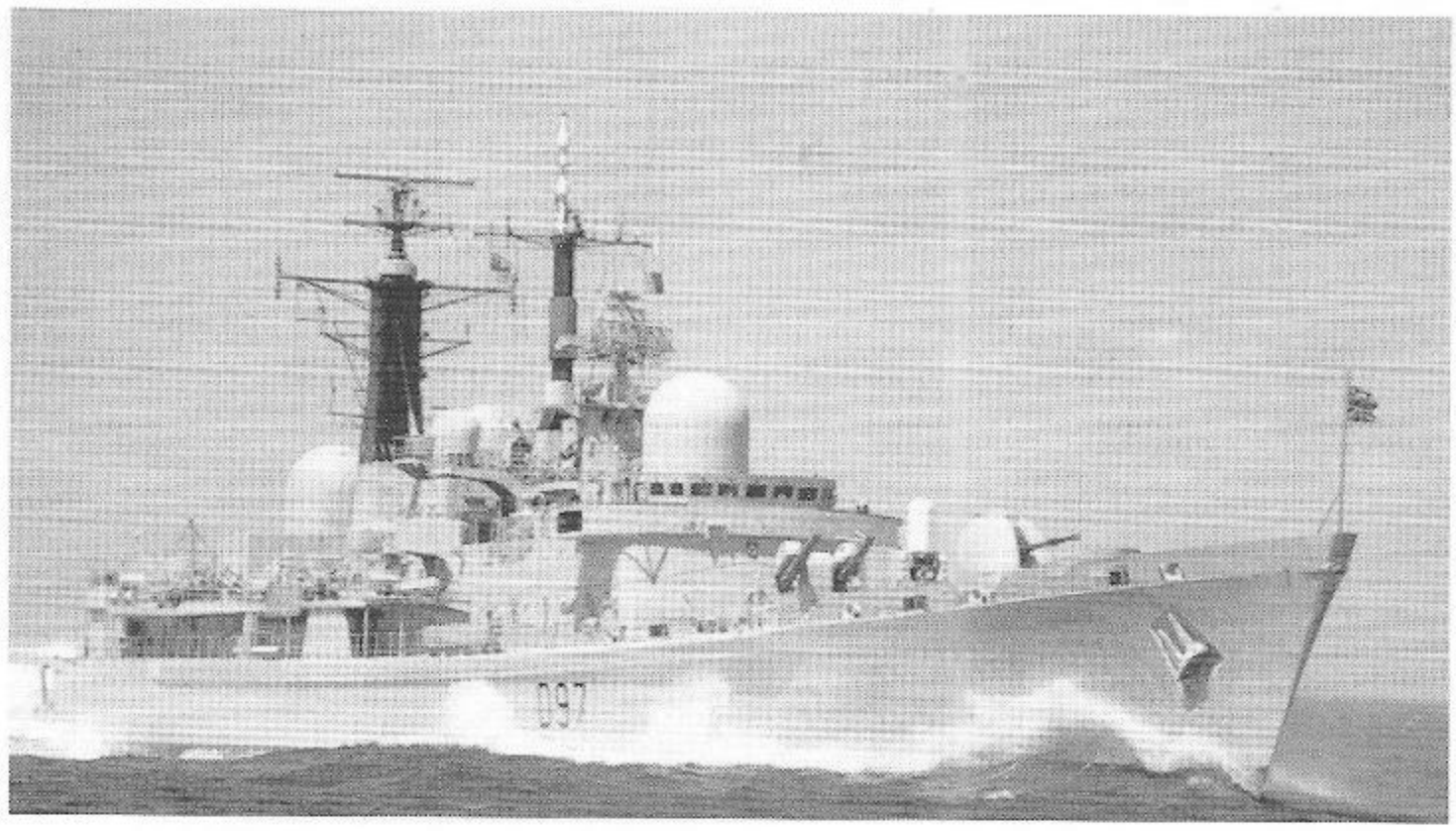
Specifications
Length: 4.36 m (14.3 ft)
Diameter: 42 cm (16.53 in)
Wing span: 91 cm (35.8 in)
Weight: 550 kg (1,213 lb)
Speed: Mach 3.5
Range: 21.5 n miles (40 km)
Altitude: 100-18,500 m (300-60,000 ft)
Guidance: Semi-active radar
Booster: RO Chow rocket; 16,000 kg thrust for 3 s
Sustainer: Rolls-Royce Odin ramjet

Manufacturer/Contractor
British Aerospace.

TORPEDOES

STWS Mk 2 anti-submarine torpedo launching system

All four ships are fitted with two sets of triple 324 mm Plessey STWS (Shipborne Torpedo Weapon System) torpedo tubes. Each group consists of a triple-tube launcher, a launch control, and a presetter unit, which are linked to the launchers through local control panels. On the possibility of action, the launchers are manually trained to an angle of 45° using a training handle



Edinburgh *(D 97) at an interim stage in its career, with a 'one-off' CIWS installation. It was planned to install lightweight Seawolf in these ships and space was reserved for the installation amidships (where Vulcan Phalanx is now installed).* Edinburgh *was earmarked to be the first but it became necessary to install a CIWS because of delays in Seawolf and a single Mk 15 was mounted on the foredeck (where the arc of fire must have been extremely limited). The Mk 15 installation, in turn, necessitated a bulwark to deflect spray off the gun* (Jane's/HM Steele)

installed between the two lower tubes, but thereafter they are remotely operated. The tubes themselves are made of glass fibre-reinforced epoxide resin and mounted in a triangular configuration. STWS 2 is designed to operate with the Mk 46 and the Sting Ray lightweight torpedoes. It has electrically operated muzzle doors while the presetter/launch controller features Motorola 30800 microprocessors. It also features a strengthened mounting, better access to the tubes and improvements in the diagnostic and heater systems.

Specifications
Length: 3.65 m (11.97 ft)
Height: 1.4 m (4.60 ft)
Width: 1.23 m (4.04 ft)
Weight: 1,560 kg (3,440 lb) (unloaded)

Manufacturers/Contractors
Marconi Underwater Systems Ltd.
GEC Plessey Naval Systems Inc.

GEC-Marconi Stingray lightweight anti-submarine weapon
The Stingray is an advanced lightweight ASW torpedo designed for use in either deep or shallow waters. The sonar is multiband and multibeam, the narrowband capability giving good Doppler discrimination against slow or quiet targets, while the broadband capability provides target discrimination, range and bearing resolution. The acoustic beam sweeps the whole volume of the water from the surface to the maximum operating depth. The warhead is a Royal Ordnance directed-energy warhead, containing 35 kg of Torpex, which demands high-accuracy guidance to ensure the torpedo strikes the most vulnerable part of the target. The computer can be reprogrammed 'through the skin' whenever updated software, or programs tailored to a particular customer's operational requirements are required. These programs then adapt themselves to the particular tactical and environmental conditions in which the torpedo operates. The computer also controls the signals, beam form, speed and trajectory of the weapon. The weapon is powered by a Chloride seawater-activated magnesium-silver chloride battery with entrance and exit ports for the water. The reaction is controlled by recirculating hot, part-spent seawater using a pump while simultaneously controlling the amount of cold seawater reaching the battery. Power is produced 1.5 seconds after the weapon enters the water. The power is used for a Lucas DC electric motor which drives two contrarotating propulsors housed in a duct to form the pump-jet. The control surfaces are actuated by an electrohydraulically driven proportional control system developed by BAe Dynamics Group. In operation, when the torpedo enters the water and frees itself from its parachute, it sets up a preprogrammed search pattern designed to maximise the chances of target detection. On acquiring the target, the computer and active/sonar sensors make it almost impossible for the target to evade attack. The advanced software of the guidance/homing system allows it to filter out background noise and decoys and to make interception rather than perform a conventional tail-chase attack. It is believed to have a maximum speed of about 45 knots with an estimated endurance of some eight minutes at that speed.

Specifications
Length: 2.59 m
Diameter: 324 mm
Weight: 267 kg (in air)
Warhead: 35 kg
Speed: 45 kts
Range: 6 n miles (11 km)
Depth: 750 m

Manufacturer/Contractor
GEC-Marconi Underwater Weapons Systems Ltd.

GUNS

Vickers 114 mm (4.5 in)/55 Mk 8 multipurpose gun
The Type 42 mounts a single 114 mm (4.5 in) Mk 8 gun in A position. This gun mounting is designed to provide quick reaction short-range air defence, to engage surface targets including fast attack craft, and to provide gunfire support to ground forces. The weapon system consists of the gun mounting, the ammunition feed system, the remote power control system, and the captain-of-turret panel.

The barrel is 6.22 m long, fitted with a muzzle brake and fume extractor, and has a life of 3,300 rounds EFC (Equivalent Full Charges). The mounting is completely enclosed in a glass fibre shield which protects it against the environment, blast and shrapnel. The loading system is hydraulically operated, with an autoloader which is manually fed by two loaders and has a capacity of six rounds. The hoist transfers them in two stages to the turret from where they are raised by a pivoting loading arm to the breech where they are inserted by a power rammer. After the shell is fired, the case is extracted automatically and ejected through a chute in the front of the mounting.

Specifications
Calibre: 114 mm
Length of barrel: 55 calibres
Traverse: 340° at 40°/s
Elevation: −10 to +55° at 40°/s
Muzzle velocity: 868.7 m/s
Weight of projectile: 21 kg
Rate of fire: 25 rds/min
Range:
anti-surface: 11.9 n miles (22 km)
anti-air: 6,000 m (20,000 ft)
Crew: 4 (gun captain (CIC), loading supervisor, 2 loaders)

Manufacturer/Contractor
Vickers Shipbuilding and Engineering Ltd, Barrow-in-Furness, Cumbria, UK.

2 Oerlikon/BMARC 20 mm GAM-BO1; 55° elevation; 1,000 rds/min to 2 km.

2 Oerlikon 20 mm Mk 7A; 50° elevation; 800 rds/min to 2 km; weight of shell 0.24 kg.

Gloucester *(D 96). It was this ship that shot down an Iraqi Silkworm missile during the Gulf War. The missile was heading straight for USS* Missouri *but was destroyed by two Sea Dart missiles launched by the British ship*

20 mm Oerlikon mountings

All four ships mount have four single Oerlikons: two in Oerlikon/BMARC GAM-BO1 mountings and two in Mk 7A mountings. The Mk 7A mounting is very simple and has a shield, but the GAM-BO1 uses a swivel fork with the sidewalls having the trunnion bearings. The cradle is made of light alloy and the weapon's working parts are enclosed in a protective case whose top opens to ease maintenance and installation. The sight, shoulder rests and back support strap are all attached to the sight bracket which is adjustable for height. Usually these mountings have an optical ring sight but they can also be fitted with a lead computing sight. The ammunition box with 200 rounds is attached to the front of the mounting and the belt is fed from the right side of the gun, with spent cartridge cases being ejected between the sidewalls of the cradle into a separate compartment, while the links are collected in a bag on the other side of the mounting.

Manufacturers/Contractors

Royal Ordnance, Medium Calibre Gun Division (mounting).
Oerlikon Contraves AG, Defence (cannon).

Specifications

Mounting	GAM-BO1	Mk 7A
Elevation	55°	50°
Gun Model	KAA	Mk 2
Calibre	20 mm	20 mm
Length of barrel	85 cal	70 cal
Effective range surface target aircraft	 2,500 m (2,700 yd) 1,200 m (1,300 yd)	 1,500 m (1,650 yd) 1,150 m (1,250 yd)
Rate of fire	1,000 rds/min	800 rds/min
Round weight	320-345 g	241 g
Projectile	110-125 g	122 g

Hughes Mk 15 CIWS Phalanx

There are two Hughes Mk 15 Phalanx close in weapons systems (CIWS), one either side of the stack. These weapons provide the innermost layer of defence against anti-ship missiles and consist of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications

Gun
Calibre: 20 mm
Length of barrel: 53 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)

Mounting
Weight: 5.42 t (Block 0), 6.18 t (Block 1)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse-Doppler

Manufacturers/Contractors

General Dynamics (system).
General Electric (gun).
Lockheed Electronics (radar).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Racal Outfit UAA-2

Outfit UAA-2 (also known as 'Abbey Hill') is a solid-state development of Outfit UAA-1, which is a passive reception, signal analysis and direction-finding system, using IFM receivers. Frequency range has not been published but is believed to be in the 1 to 18 GHz range. The intercept and DF antenna is a series of radome-covered horns normally mounted under the masthead radar. Accuracy of measurement is reported to be 1.5 MHz in frequency and 3° in bearing. There is also a threat identification system. The UAA-2 upgrade features solid-state electronics in the system front end, an improved threat library and an increase in the number of warner channels.

Manufacturer/Contractor

Racal Radar Defence Systems Ltd, Chessington, Surrey, UK.

Type 675 radar detection and jamming system

Two Type 675 active/passive EW systems are installed in Batch 3 ships. This system is designed to counter a wide range of operational threats, particularly those of radar-guided missiles. The system counters and confuses surveillance and missile homing radars by the use of selective jamming techniques for both area and point defence. Azimuth coverage is 360° with an elevation cover of 50° and a detection range of up to 500 km. Two antenna mounts, both with mechanical steering to give full azimuth and elevation coverage, ensure uninterrupted all-round view. Each mount carries a direction-finding receiving antenna together with transmit antennas. Received signals are analysed to identify those which may pose a threat and the selected signals are processed to allow generation of the jamming signal.

High-power transmitter subsystems, matched to the antenna, provide jamming capability against several types of target simultaneously. A comprehensive ECM library stores the appropriate countermeasures to a range of potential threats and, on receipt of a warning from the ESM system, the ECM processor selects the appropriate jamming mode to give fast response.

Manufacturer/Contractor

THORN EMI Electronics Ltd, Sensors Group, Crawley.

Pilot's view of Manchester's *flight deck as the aircraft comes in on finals. Note also the 'sword' type antennas to the right of the mainmast which are part of an ESM system* (Jane's/HM Steele)

DECOYS

Outfit DLB; 4 Sea Gnat 130 mm/102 mm 6-barrelled launchers.

Graseby Type 182 towed torpedo decoy

The Type 182 towed torpedo decoy is designed to decoy both active and passive homing torpedoes, using signals electronically generated within the ship and fed, via the towing cable, to electroacoustic transducers within the towed body. The Type 182 produces two independently controllable output signals which are radiated simultaneously from the towed decoy. An amplitude modulated noise signal simulates the ship's propeller noise and causes passive-homing torpedoes to be seduced away from the ship towards the towed decoy. The second signal is a swept CW signal, which simulates sonar echoes, in order to confuse or jam the guidance system of active homing torpedoes, thus causing them to miss the ship. The frequency bands covered by both types of output are switchable to meet tactical scenarios and to enable concurrent operation of other sonar and communication equipments.

Specifications

Towed decoy:
diameter: 533 mm (21 in)
length: 2.05 m (6.57 ft)
weight: 74 kg (163 lb)
Towing cable:
length: 411 m (1,350 ft)
diameter: 14.48 m (0.57 in)
weight: 269 kg (593 lb)

Manufacturer/Contractor

Graseby Marine (Graseby Dynamics Ltd), Watford, UK.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Ferranti ADAWS 8/ADIMP (Outfit DAH) command and weapon control system

Type 42 Batch 3 ships were originally fitted with ADAWS 8 (Outfit DAH) but all have now been upgraded to ADAWS Improvement Programme (ADIMP) standard, *Manchester* having been the first to complete the change. ADIMP is an extension of the ADAWS which introduces a degree of federation through the introduction of the J & S Marine Combat Systems Highway (CSH) and the application of VME and the Motorola 68000 family of microprocessors. Two new processors, Ferranti F2420, are used, each with 3 MBytes of memory and capable of 3.8 Mips. The display systems are upgraded with Motorola 68030 microprocessors to increase their capability and this permits improvements in MMI. ADIMP also involves supplying further peripheral systems, including an Outfit LFD track combiner, based upon Motorola 68020 microprocessors, which assesses all track messages along the CSH, analysing and correlating them to produce more accurate track data. A Data Link Processing System links all tactical datalinks, including Link 16, into the CSH. It is also planned to provide ADIMP with the Electronic Warfare Control Processor (EWCP) a knowledge-based system which will integrate electronic warfare hard kill/soft kill elements such as Sea Gnat. Initially the EWCP will be only installed in the aircraft carriers but may later be extended to the Type 42 destroyers.

Captain's Comcat Aid

Integrated in ADIMPS is the Captain's Combat Aid (CCA), based upon the Nautic console used in Nautis (qv) with Motorola 68040 microprocessors and INMOS transputers. This contains embedded tactical doctrine and data on both the ship's performance and that of its weapon systems. Using sensor data acquired through the CSH, this recommends the optimum course in multithreat scenarios.

Manufacturer/Contractor

Ferranti International Defence Systems Integration (prime).

COMMUNICATIONS AND DATALINKS

Matra Marconi SCOT 1C Satcom
Link 10
Link 11
Link 14
Marisat
Link 16 (JTIDS) (D 97 — 1996; others to follow)
FLTSATCOM

WEAPONS CONTROL

GWS. 30 Mod 2

The Sea Dart missile is part of GWS.30 (Guided Weapon System), which is composed of a number of elements. The tracker-illuminator is the Marconi Radar Systems Type 909, a G/H-band system with a 2.44 m cassegrain antenna in a cupola assembly. The radar head and radar cabin, with its transmitter/receiver and supporting electronics are produced as a single prefabricated assembly to assist functional testing as well as reducing installation and replacement times. The Type 909I (I = improved) has an enhanced transmitter and signal processor. Both systems are, however, capable of only one channel of fire and consequently each ship has two systems to provide 360° coverage. Targets are initially detected by the long-range search radar (Marconi Type 1022), supplemented by the target indication radar (Siemens Plessey Type 996). The Type 1022 is a D-band radar with a squintless-feed antenna to provide good sidelobe performance. It has a synthesiser-driven TWT transmitter by Signaal, pulse-to-pulse coherence and a pulse-compression receiver with MTI. The Type 996 is also an E/F-band system based upon the Plessey AWS-5 with a stabilised planar array antenna and a 3D capability. The semi-automatic fire-control system features a Ferranti data handling system with two FM1600 computers, and Marconi Underwater Systems Ltd (MUSL) display systems. The

Manchester *(D 95) in the Gulf in 1995. Radamec 1000 electro-optic directors are mounted in the bridge wings with 7.62 mm general purpose machine guns behind them* (Jane's/H M Steele)

system evaluates target priorities, assigns a tracker and, after the missile has been launched, issues guidance commands. The GSA 1 system is installed as a back up.

Radamec 2100 series optronic surveillance director

There are two Radamec System 2100 electro-optical surveillance systems, each consisting of a stabilised, remotely operated director. The director has a full sector auto-scan facility and is used for target identification. It may be integrated with display systems of the customer's choice. Sensors include the HK 202 daylight TV or HK 203 low-light TV cameras and a thermal imager. The HK 202 can detect a 10 m² target at 15 km and the HK 203 can detect it at 4 km. The thermal imager could detect such a target at 13 to 18 km.

Manufacturer/Contractor

Radamec Defence Systems Ltd.

SONARS

Ferranti-Thomson Type 2050 sonar

Type 2050 is being progressively installed in the Type 42 ships, replacing the Type 2016. The system introduces digital signal processing and distributed data processing using Ferranti Digital Signal Processing (DSP) cards and multiple Ferranti Argus M700 processors. The provision of extensive data processing facilities and improved man/machine interfaces allows one operator to control the complete system. The equipment will interface to the combat system data highway, feeding data to the Ferranti ©ACS action-information system.

Type 2050 operates at 4.5 to 7.5 kHz, using 64 5.5° beams.

The array can be installed in bow or keel domes, but in the case of the Type 42s, it is the latter.

Manufacturer/Contractor

Ferranti-Thomson Sonar Systems UK Ltd, Stockport, UK (prime system contractor).

GEC-Marconi Type 2016 sonar

Type 2016 replaced the original sonars in the Type 42, but is now itself being replaced by the Type 2050; it remains in service, however, in some. Type 2016 is a hull-mounted panoramic surveillance and attack sonar with facilities for classification and multiple target tracking. Interference between nearby vessels using the Type 2016 sonar is largely eliminated by the use of a new type of broadband transducer. The sonar display console is designed for manning by a single operator under normal cruise conditions, who is able to initiate the preparatory actions necessary for urgent action. Digital data processing facilities are based on use of Ferranti computer equipment, with other subcontractors including Marconi Radar.

The Type 2016 roll-stabilised array has 64 staves, each with 12 elements, producing two beams; one is just below the horizontal, while the other is at 7° below horizontal to penetrate under the surface layer. Transmission frequencies are 5.5 kHz, 6.5 kHz and 7.5 kHz, and total transmitter power is 44 kW. Type 2016 is fitted in a ribless monocoque glass-reinforced plastic sonar dome on the keel, array stabilisation being either hydraulic or by electronic beam-steering.

Manufacturer/Contractor

GEC-Marconi Naval Systems Ltd, Sonar Systems Division, Templecombe, Somerset, UK (prime).

Kelvin Hughes Type 162M

The Type 162M ('Cockchafer') is a sideways-looking, target detection sonar whose main use is in detecting and classifying seabed targets, such as a bottomed submarine. There are three transducers: one faces downwards at 25° below the horizontal, while the other two face sideways to cover a 3° wide and 40° vertical sector. The transmitter delivers 40 W to the central, downward-looking transducer and 80 W each to the side-looking transducers. The set operates at 50 kHz and accuracy is <2 per cent over ranges of 270 m (300 yd) and 550 m (600 yd).

Manufacturer/Contractor

Kelvin Hughes

RADARS

Type	Type 1022	Type 996	Type 1006	Type 909I (two)
Manufacturer	Marconi/Signaal	Marconi	Kelvin Hughes	Marconi
Role	Long-range air search	Surface search	Navigation	Fire control
Band	D	E/F	I	I/J
Beam	2.2 × csc² to 40°	1.4 × 1.5°	1 × 18°/ 0.75 × 18°	
Peak power	5.2 kW (mean)	125 kW	25 kW	
Gain	30 dB	41 dB	31 dB/34 dB	
Pulsewidth	35/69 µs	low angle – 65 µs; high angle – 31.5 µs	0.8 or 0.25 µs/ 0.75 µs	
PRF	1,000/5,000 pps	550-3,000 µs	1,600/800 pps	
Scan rate	7.5/15 rpm		24 rpm	
Typical range	145 n miles (265 km)		64 n miles (118 km)	

AVIATION

AVIATION FACILITIES

Specifications

Flight deck: 14.2 × 12.26 m (46 × 40.2 ft)
Hangar: 12.6 × 10.6 m (41.6 × 35 ft)

HELICOPTERS

1 Westland Lynx HMA Mk 8

Specifications

Dimensions:
main rotor diameter: 12.80 m (42.00 ft)
tail rotor diameter: 2.21 m (7.25 ft)
length overall (rotors turning): 15.165 m (49.75 ft)
Weights
empty: 2,740 kg (6,040 lb)
empty, equipped (ASW): 3,343 kg (7,370 lb)
Performance:
cruising speed: 125 kts (232 km/h; 144 mph)
speed for max endurance: 70 kts (130 km/h)
max rate of climb: 661 m (2,170 ft)/min
time on station (ASW) 50 n miles (93 km) radius: 2 h
max range: 320 n miles (593 km)
max endurance: 2 h 50 min
Power plant: 2 Rolls-Royce Gem 41-1 with max contingency rating of 835 kW (1,120 shp)
Crew: 2, pilot and co-pilot/observer
Radar: GEC-Marconi ARI5979 Seaspray Mk 1 lightweight search and tracking radar
Mission: Racal MIR-2 Orange Crop passive radar detection system; CAE Electronics AN/ASQ-504(V) internal MAD, optional GEC Sandpiper FLIR
General: ASW armament includes two homing torpedoes, two Mk 11 depth charges, or four Sea Skua semi-active homing missiles

PROPULSION

Specifications

System: combined gas turbine or gas turbine (COGOG)
Main machinery:
cruise: 2 Rolls-Royce Tyne RM1C gas turbines; 8 MW (10,680 hp) sustained
boost: 2 Rolls-Royce Olympus TM3B gas turbines; 32 MW (43,000 hp) sustained
Shafts: 2
Propellers: cp

FURTHER INFORMATION

PROGRAMME

These ships are known variously as Type 42C, Type 42 Batch 3 and the 'Manchester' class. As with Batches 1 and 2 these ships are designed to provide area air defence for a task force.

The completion of the last three ships was delayed to allow modifications resulting from experience in the Falklands (Malvinas) war to be included.

DESIGN

These ships are simply stretched Type 42 Batch 1 ships and from the bridge screen aft they are virtually identical with the earlier ships. They differ, however, in having a 16.1 m (52.82 ft) longer bow section with greater sheer, which enhances sea-keeping and provides extra space, the earlier ships being regularly criticised for their 'cramped' conditions. (It is reported in some quarters that this longer bow is not a new feature, but the restoration of the original design, which was shortened in Batches 1 and 2 as an economy measure). The increase in waterline length results in a slight increase in speed for the same installed power.

Weapons systems and sensors are the same as in Batches 1 and 2, except that Batch 3 ships have received the ADIMPS enhancement to ADAWS.

The Batch 3 ships have all been fitted with a strengthening beam on each side to prevent twisting; this increases the displacement by 50 tonnes and the width by 0.61 m (2 ft).

In 1991 *Edinburgh* was fitted with a bulwark and a single Mk 15 Phalanx on the foredeck but both were removed in 1995.

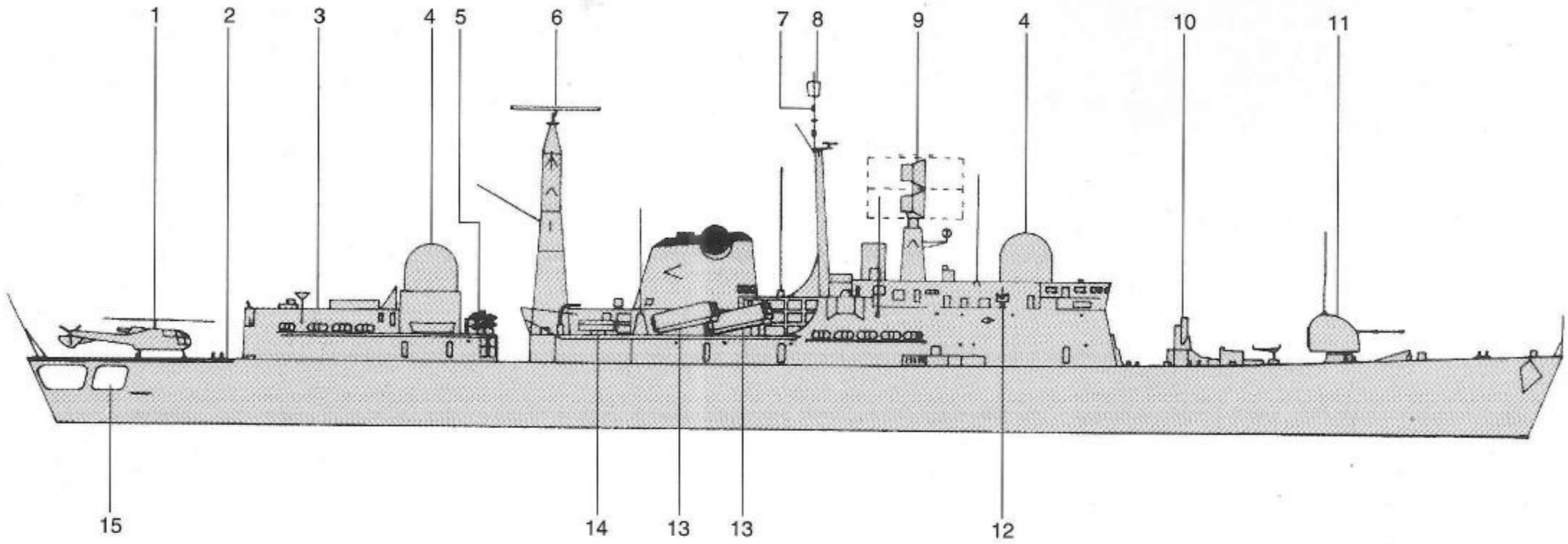
During the Gulf War a Batch 3 ship, *Gloucester,* fired two Sea Dart SAMs at an incoming Silkworm missile on 25 February 1992, one of which succeeded in destroying the target.

OPERATIONAL

The helicopter carries the Sea Skua air-to-surface weapon for use against lightly defended surface ship targets. Ships may be fitted with DEC laser dazzle sight and additional decoy flare launchers on operational deployments.

Manchester *(D 95) in its original state. Note the absence of the strengthening beam which had to be fitted to overcome torsional problems resulting from the increased length* (VSEL)

HERCULES (TYPE 42)



Hercules (Ian Sturton)
1 *SA 319B Alouette III helicopter* **2** *Flight deck* **3** *Hangar* **4** *Type 909 fire control (for Sea Dart SAM)* **5** *Corvus chaff launcher* **6** *Type 992Q radar (surface search)* **7** *UHF communications antennas* **8** *FH5 direction finding array* **9** *Type 965P radar (air search)* **10** *Sea Dart GWS.30 launcher* **11** *114 mm (4.5 in) gun Mk 8* **12** *Oerlikon 20 mm Mk 7* **13** *MM 38 Exocet launchers* **14** *324 mm ILAS Mk 3 torpedo launchers* **15** *GI 738 towed torpedo decoy*

GENERAL SPECIFICATIONS

Country of origin: UK
Operator: Argentina

Class: HERCULES (UK TYPE 42)

Built: 2
Active: 2

Displacement:
standard: 3,150 t
full load: 4,100 t

Dimensions
Length: 125.6 m (412.0 ft)
Beam: 14.3 m (47.0 ft)
Draught: 5.8 m (19 ft) (screws)

Speed:
max: 29 kts
cruise: 18 kts (Tynes)
Range: 4,000 n miles at 18 kts

Complement: 300

SHIPS

HERCULES (D 1) (ex-28)

Builder	Vickers, Barrow-in-Furness, UK
Laid down	16 Jun 1971
Launched	24 Oct 1972
Commissioned	12 Jul 1976

SANTISIMA TRINIDAD (D 2)

Builder	AFNE, Rio Santiago, Argentina
Laid down	11 Oct 1971
Launched	9 Nov 1974
Commissioned	Jul 1981

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Exocet MM 38 medium-range anti-ship missile

Four Aerospatiale MM 38 Exocets are mounted abreast the stack in individual ITS (Installation de Tir Standard) launcher-containers, within which they are suspended from a launch rail in the ceiling. These launcher-containers point outwards and are inclined at an angle of 12° to the horizontal. Targets are acquired by the ship's search radar and the operator then aligns the axial gyros in the target's direction and begins the initiation sequence. This involves turning on the thermal battery, releasing the mechanical safety locks, igniting the booster and, finally, breaking the umbilical cord; the total process takes some 60 seconds. Exocet has a 105° off-axis engagement envelope and can perform one 15° change of course during its flight.

The attack consists of three phases:

Cruise phase. The cruise phase starts as the missile clears the container and, powered by the sustainer motor, flies towards the general location of the target, at a height of about 100 m which is low enough to reduce the chance of detection but adequate for target acquisition. This phase can be as long as 22 km and ends when the seeker acquires the target. This seeker is a Dassault Electronique ADAC (Auto Directeur Anti-Clutter) active monopulse radar, working in the I-band (8-10 GHz), which has a typical range of 13 n miles (24 km) against FACs.

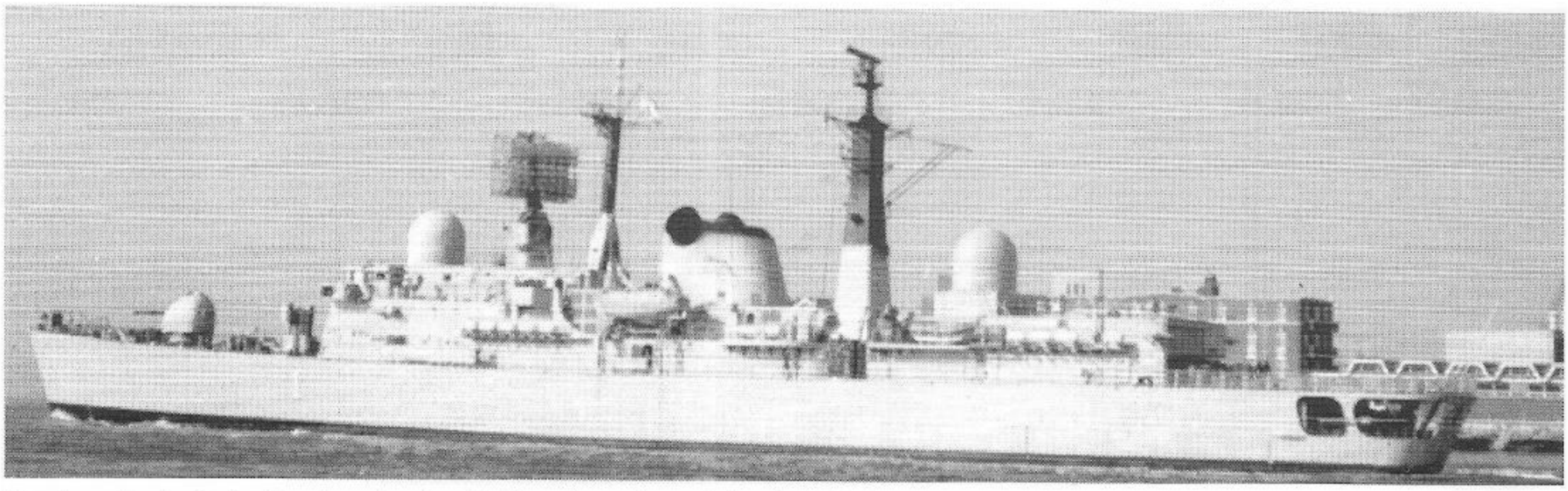
Approach phase. On detecting the target the missile descends to 9 to 15 m in the approach phase.

Terminal phase. During this final phase the missile descends to 8 m (2 to 5 m in a calm sea) for a sea-skimming run in to the target.

A salvo may be fired in 12 to 20 seconds.

Specifications

(MM 38)
Length: 5.21 m (17.1 ft)



Hercules, *showing the 'ear' engine exhausts, which have been changed since in the RN but not the Argentine ships. Since this picture was taken, the boat and davits beside the stack have been removed and replaced by MM 38 Exocet launchers, two on each side of the stack*

Diameter: 35 cm (13.7 in)
Wing span: 1.00 m (3.28 ft)
Weight: 735 kg (1,625 lb)
Speed: Mach 0.9
Range: 2-22.5 n miles (4-42 km)
Guidance: Inertial and active radar
Sustainer motor: SNPE Eole alloy-cased CDB; weight 151 kg (333 lb); max burn time 93 s
Booster: 100 kg SNPE Epervier boost motor; burn time of 2.4 s
Warhead: Luchaire 165 kg (363.7 lb) fragmentation warhead
Fuzes: delayed impact fuze and autopilot-controlled proximity fuze

Manufacturer/Contractor
Aerospatiale Tactical Missiles, Chatillon Cedex, France.

SURFACE-TO-AIR MISSILES (SAM)

BAe Sea Dart missile system
There is a single, twin-arm Sea Dart launcher on the foredeck, with a magazine holding 22 rounds below. The Sea Dart missile is powered by a ramjet, with a rocket booster for launch.

Targets are initially detected by the long-range Type 965 search radar, supplemented by the Type 992 target indication radar. The semi-automatic fire-control system, which features a Ferranti data handling system with two FM1600 computers, and Marconi display systems, evaluates target priorities, assigns a tracker and, after the missile has been launched, issues guidance commands.

The tracker-illuminator is the Marconi Type 909 which is capable of only one channel of fire. Consequently each ship has two systems to provide 360° coverage, these being housed in the prominent hemispherical radomes, one on the bridge roof, the other just abaft the mainmast.

The missile handling-launching system was designed by VSEL. The missiles are stored vertically in the magazine and are hoisted to an intermediate magazine which lies below the twin-rail launcher, from which it is separated by two flash doors. For loading, the launcher must face forward with the launch rails vertical and the flash doors then open and the missiles are raised automatically.

The targets are detected by the search/target indication radars and the data are transmitted to the fire-control system through the ship's ADAWS-4. Within the fire-control system the situation is evaluated and the operator selects a target and the most appropriate tracker. The fire-control computer passes target data to the tracker which locks on to the target and slews the launcher in the target's direction and then waits until the target is within range, when the missile is launched. The rocket booster takes the missile clear of the ship, accelerating it to Mach 2, at which point the ramjet ignites and the booster falls away. The missile then accelerates to Mach 3.5 and, using proportional navigation, homes on the reflected energy from the illuminator until the target is intercepted. The fire-control system then evaluates the engagement and prepares for the next one.

Specifications
Length: 4.36 m (14.3 ft)
Diameter: 42 cm (16.53 in)
Wing span: 91 cm (35.8 in)
Weight: 550 kg (1,212 lb)
Speed: Mach 3.5
Range: 21.5 n miles (40 km)
Altitude: 100-18,500 m (328-60,700 ft)
Guidance: Semi-active radar
Booster: RO Chow rocket; 16,000 kg (35,273 lb) thrust for 3 s
Sustainer: Rolls-Royce Odin ramjet

Manufacturer/Contractor
British Aerospace, UK.

TUBES

Whitehead ILAS-3 (B515) anti-submarine torpedo launching system
ILAS-3 (B515) consists of three 324 mm diameter torpedo tubes mounted on the open deck, with one installation on each side of the ship, abreast the mainmast. The tubes are manually loaded and trained but remotely operated from the combat information centre, although emergency local operation is possible.

Specifications
Length: 3.4 m (11.15 ft)
Height: 1.2 m (3.93 m)
Width: 1.285 m (4.21 ft)
Weight: 1,050 kg (2,315 lb) (unloaded)

Manufacturer/Contractor
Whitehead, Division of Gilardini SpA.

TORPEDOES

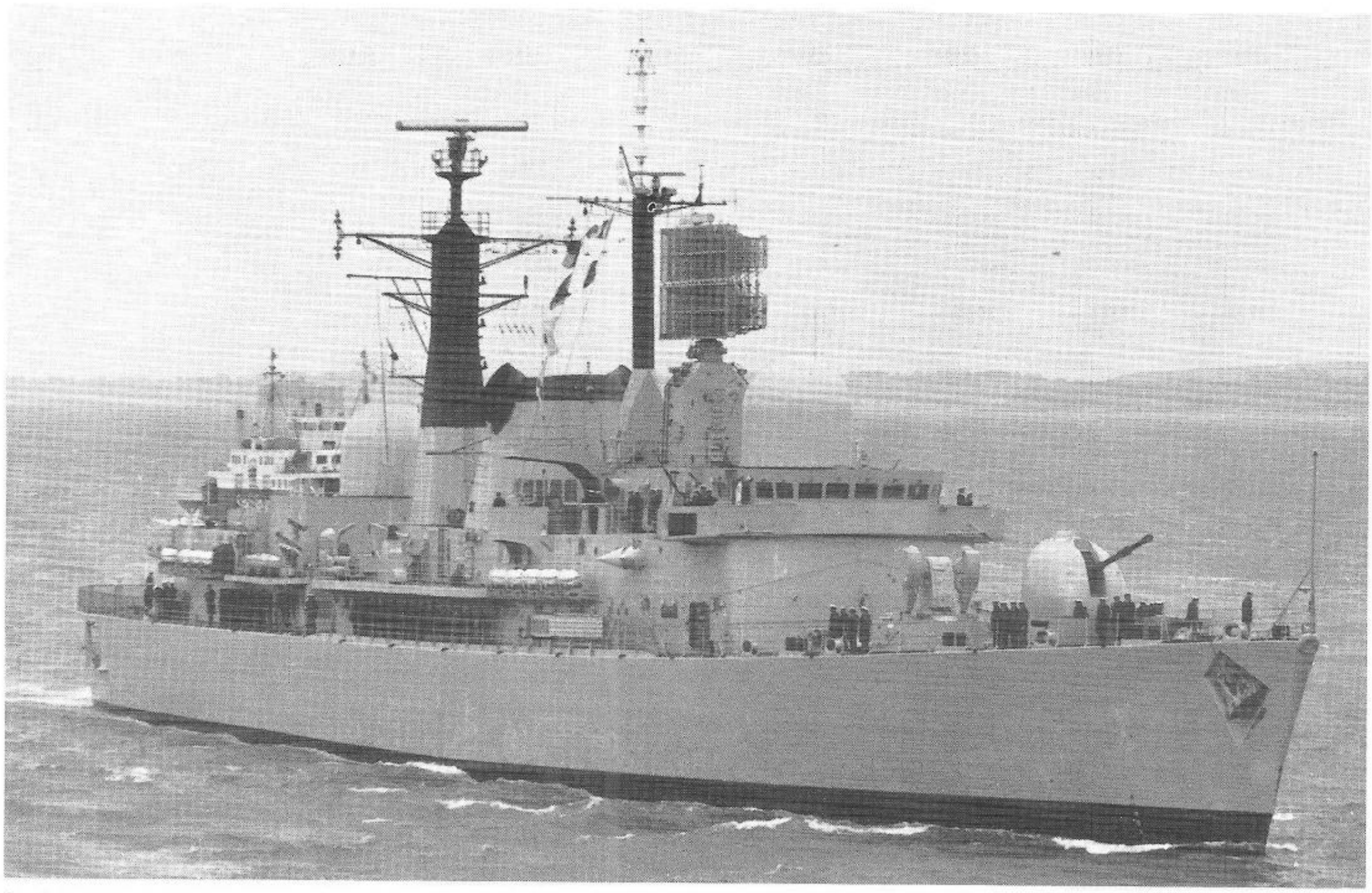
Whitehead A244/S lightweight anti-submarine torpedo
The torpedo used by the 'Hercules' class destroyers is the Whitehead A244/S. Upon launching, the A244/S initially steers a straight course and, if the target is not detected, it then begins a search pattern which may be either a spiral between preselected depths or a helix pattern.

Specifications
Length: 2.7 m (8.86 ft)
Diameter: 324 mm (12.75 in)
Weight: 215 kg (474 lb)
Warhead: 34 kg (80 lb) shaped charge HBX-3 HE
Propulsion: Electric; silver/zinc batteries
Range: 3.5 n miles (6 km)
Speed: 30 kts
Guidance: Active/passive sonar, self-adaptive programmed patterns

Manufacturer/Contractor
Whitehead SpA, Salviano, Italy.

GUNS

Vickers 114 mm (4.5 in)/55 Mk 8 multipurpose gun
The Argentine ships mount the same single 114 mm (4.5 in) Mk 8 gun in A position as their British counterparts. This gun mounting is designed to provide quick-reaction short-range air defence, to engage surface targets including fast attack craft, and to provide gunfire support to ground forces. The weapon system consists of the gun mounting, the ammunition feed system, the



Santisima Trinidad *(D 2). The second in the class, this ship was built at the AFNE yard in Argentina, a process which added very considerably to the time taken, being laid down in 1971 and commissioned in 1981*

remote power control system, and the captain-of-turret panel.

The barrel is 6.22 m long, fitted with a muzzle brake and fume extractor, and has a life of 3,300 rounds EFC (Equivalent Full Charges). The mounting is completely enclosed in a glass fibre shield which protects it against the environment, blast and shrapnel. The loading system is hydraulically operated, with an autoloader which is manually fed by two loaders and has a capacity of six rounds. The hoist transfers them in two stages to the turret from where they are raised by a pivoting loading arm to the breech where they are inserted by a power rammer. After the shell is fired the case is extracted automatically and ejected through a chute in the front of the mounting.

Specifications

Calibre: 114 mm (4.5 in)
Length of barrel: 55 calibres
Traverse: 340° at 40°/s
Elevation: −10 to +55° at 40°/s
Muzzle velocity: 868.7 m/s (2,850 ft/s)
Weight of projectile: 21 kg (46.3 lb)
Rate of fire: 25 rds/min
Range:
anti-surface: 11.9 n miles (22 km)
anti-air: 6,000 m (20,000 ft)
Crew: 4 (gun captain (CIC), loading supervisor, 2 loaders)

Manufacturer/Contractor

Vickers Shipbuilding and Engineering Ltd, Barrow-in-Furness, Cumbria, UK.

20 mm Oerlikon Mk 7A mountings

Both ships mount two single Oerlikons in the bridge wings. The Mk 7A mounting is very simple, but has a shield.

Specifications

Elevation: 50°
Gun Model: Mk 2
Calibre: 20 mm
Length of barrel: 70 calibres
Effective range
anti-surface: 1,500 m (1,650 yd)
anti-air: 1,150 m (1,250 yd)
Rate of fire: 800 rds/min
Round weight: 241 g
Projectile: 122 g

Manufacturers/Contractors

Oerlikon Contraves AG, Defence.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

Racal RDL-257

RDL-257 is a radar warning receiver covering the frequencies 1 to 18 GHz and gives the frequency of a particuler threat.

Manufacturer/Contractor

Racal Defence Systems, Chessington, Surrey, UK.

FH-5

FH-5 is a Second World War vintage British HF direction-finding set. This is the 'bird-cage' antenna at the head of the foremast.

ELECTRONIC COUNTERMEASURES (ECM)

Racal RCM-2

Hercules only. The Racal RCM-2 is a jammer, covering the 5 to 15 GHz range in two bands.

DECOYS

Graseby GI 738 towed torpedo decoy

The Graseby GI 738 is the export version of the British Navy's Type 182 towed torpedo decoy, which is designed to decoy both active and passive homing torpedoes, using signals electronically generated within the ship and fed, via the towing cable, to electroacoustic transducers within the towed body. The GI 738 produces two independently controllable output signals which are radiated simultaneously from the towed decoy. An amplitude modulated noise signal simulates the ship's propeller noise and causes passive homing torpedoes to be seduced away from the ship towards the towed decoy. The second signal is a swept CW signal, which simulates sonar echoes, in order to confuse or jam the guidance system of active homing torpedoes, thus causing them to miss the ship. The frequency bands covered by both types of output are switchable to meet tactical scenarios and to enable concurrent operation of other sonar and communication equipments.

Specifications

Towed decoy:
diameter: 533 mm (21 in)
length: 2,005 m (6.57 ft)
weight: 74 kg (163 lb)
Towing cable:
length: 411 m (1,348 ft)
diameter: 14.48 m (0.55 in)
weight: 269 kg (593 lb)

Manufacturer/Contractor

Graseby Marine (Graseby Dynamics Ltd), Watford, UK.

Knebworth Corvus

Two Knebworth Corvus chaff launchers.

Specifications

Modes of operation: Distraction decoy; centroid decoy
Bearing arc (launcher axis): 60-120° (normal)
Bearing arc (tube axis): 15-165° (max)
Launcher weight: 585 kg (1,290 lb)
Off-launcher equipment weight: 42 kg (92.6 lb)
Tube diameter: 195 mm (7.67 in)
Tube length: 1.6 m (5.25 ft)
Weight: 25 kg (55 lb) (empty)

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

ADAWS-4 command and weapon control system

ADAWS-4 (Outfit DAD) was developed specifically for the British Type 42 Batch 1 destroyers, which were ordered in 1967 and entered service in 1975. A modified version was developed and exported to Argentina in the two 'Hercules' class 'Type 42' class destroyers. ADAWS-4 is a mainframe architecture system based upon two Ferranti FM1600 24-bit computers, using Coral 66 language software. Each has a 262 k maximum memory and an operating speed of 100 Kops. The computers are used to process data from ship sensors, from off-ship radars through Link 1, to process the data and then to present it to the display systems. A Data Link Pre-Processor (DLPP) is included to act as an interface with the Link 1 datalink. The computers are also used to evaluate the threats from different targets and to designate them to the most appropriate weapon system. They also control the ship's weapons providing aiming and ballistic calculation data for both missiles and the 4.5 in guns. They may also be used to calculate data for controlling the operational use of both ASW helicopters and fighters. Auto-tracking of targets is available using LFX (Limited area/Full eXtraction) and LAX (Limited area Auto eXtraction) with or without auto-initiation of tracks. The system also features an AS 1077 sonar trainer, for onboard training, and is linked to the sensors and displays by a data highway.

In the Argentine version of ADAWS-4 the system operates with Marconi Type 965 air search radars. ADAWS-4 has two tactical and six Labelled Plan Displays (LPD) displays with the Combat Information Centre having a further four dedicated weapon/sensor displays.

RADARS

Type	Type 965P*	Type 992Q	Type 1006	Type 909I (two)
Manufacturer	Marconi	Marconi	Kelvin Hughes	Marconi
Role	Long-range air search	Surface search	Navigation	Fire control (Sea Dart)
Band	A	E/F	I	I/J
Beam	12 × 40°	1.25 × 15°	1 × 18°	
Peak power	450 kW	2 kW	25 kW	
Gain	20 dB	30 dB	31 dB	
Pulsewidth	3.8/10 µs	2.0 µs	0.8/0.25 µs	
PRF	400/200 pps	750 pps	1,600/800 pps	
Scan rate	8-10 rpm	15/30 rpm	24 rpm	

* Type 965P has double AKE-2 array and 1010/1011 IFF

COMMUNICATIONS AND DATALINKS

Link 10.

SONARS

Graseby Type 184M active/passive hull-mounted search sonar

Type 184M is a 360° scanning sonar incorporating both active and passive modes of operation, which provides range, bearing and target Doppler data to the fire-control computer. The equipment provides a dual-frequency transmission and three receiver systems. The latter comprise: an all-round search and tracking PPI system with eight receiving channels; a 4-beam sector search Doppler system with B-scan display; a continuous torpedo warning system with its own display. A circular 32-stave transducer array is employed. The keel-mounted, retractable dome is 3.99 m long, 1,62 m wide and 1.55 m deep. Operating frequencies are 6 kHz, 7.5 kHz and 9 kHz.

Manufacturer/Contractor

Graseby Marine (Graseby Dynamics Ltd), Watford, Hertfordshie, UK.

AB Precision Type 162M sonar

Sonar Type 162M detects and classifies both mid-water and seabed targets, displaying port and starboard recordings simultaneously on a single straight-line recorder, which has a maximum range scale of 1,200 yds. Operation is simplified by entirely automatic gain control. The three transducers are all similar and employ 49.8 kHz barium titanate elements. Their beam pattern is fan-shaped, about 3° wide and 40° vertical angle; the side-looking elements have their axes 25° below the horizontal. A loudspeaker and a socket for headphones enable signals to be monitored aurally if required. The three range scales are 0 to 300, 0 to 600 and 0 to 1,200 yds, and accuracy is better than two per cent assuming a sound velocity of 1,500 m/s (4,920 ft/s).

Manufacturer/Contractor

AB Precision (Poole) Limited, Poole, Dorset, UK.

AVIATION

AVIATION FACILITIES

Specifications

Flight deck: 14.2 × 12.26 m (46 × 40.2 ft)
Hangar: 12.6 × 10.6 m (41.6 × 35 ft)

HELICOPTERS

1 Aerospatiale SA 319B Alouette III

The Argentine Navy operates four Alouette IIIs, which are the type normally seen aboard these two ships, although SH-3Ds are also occasionally seen.

Specifications

Main rotor diameter: 11.02 m (36.15 ft)
Length overall: 12.84 m (42.15 ft)
Fuselage length: 10.17 m (33.7 ft)
Height to rotor head: 3.00 m (9.84 ft)
Weights:
empty: 1,143 kg (2,520 lb)
max take-off: 2,200 kg (4,850 lb)
Performance
max speed (never-exceed): 113 kts (210 km/h)
cruising speed: 100 kts (185 km/h)
service ceiling: 3,200 m (10,500 ft)
range: 267 n miles (495 km)
Engines: One 694 kW (870 shp) Turbomeca Artouste IIIB turboshaft derated to 425 kW (570 shp)
Crew: 7 (pilot plus six)
Weapons: In the ASW role the SA-319B can carry two lightweight torpedoes

PROPULSION

Specifications

System: Combined gas turbine or gas turbine (COGOG)
Main machinery:
cruise: 2 Rolls-Royce Tyne RM1A gas turbines; 7.4 MW (9,900 hp) sustained
boost: 2 Rolls-Royce Olympus TM3B gas turbines; 37.3 MW (50,000 hp) sustained
Shafts: 2
Propellers: cp

FURTHER INFORMATION

PROGRAMME

The contract for these two ships was signed on 18 May 1970 between the Argentine Government and Vickers Ltd, just four months after the first British ship, *Sheffield,* had been laid down. The contract provided for the first of the Argentine ships to be built at the Vickers yard at Barrow-in-Furness, UK, while the second would be built in Argentina, with British assistance, at Astilleros Navales, Rio Santiago. *Hercules,* the first ship, was delivered on time, but construction of *Santisima Trinidad* lasted from October 1971 to July 1981, this length of time being due partly to construction difficulties in the AFNE yard, but also to a terrorist attack on 22 August 1975 whilst the ship was fitting-out. This caused considerable damage which necessitated the ship being placed in a floating dock for repairs.

DESIGN

As built, the ships were generally similar to the British Type 42 Batch 1, but with a number of differences in weapons and electronic equipment. They still retain the exhaust uptakes known as 'Mickey Mouse ears' in the British Navy, and which have long since been removed in the British ships. The aviation facilities were designed for the British Lynx helicopter and the Argentine Navy operated several such aircraft, but they were so badly affected by the British embargo that they were sold and the ships now normally operate an Alouette III helicopter, although they are sometimes also seen with a Sea King. They have triple tubes for the Mk 46 ASW torpedoes. The layout of the antennas on the upper part of the mainmast is different from British Type 42s.

MODERNISATION

Combat data systems have been improved with local modifications.

First of class, Hercules *in 1980; at that time the ship's pennant number was 28, but it has since changed to D 1. The large 'bedstead' antenna is a double AKE-2 and serves the Type 965P air search radar* (H & L van Ginderen)

OPERATIONAL

Both ships participated in the 1982 Falklands (Malvinas) war. *Santisima Trinidad* was the flagship of the invasion force and later served as an anti-air escort for the carrier *Vienticinco de Mayo*, while *Hercules* operated with an independent destroyer task group.

After the war, the British Government placed an embargo on spares for the two ships, which had to be laid up for lengthy periods during the years 1983 to 1986. According to unconfirmed reports they were both offered for sale to Iran and Turkey during this period. When this proved to be unsuccessful they carried out short sea deployments in 1987, and then returned to full-time service with the Argentine fleet in 1988.

At least one took part in the Gulf War and, according to unconfirmed reports at the time, called at a UK port on its way there to receive much-needed spares which had been withheld by the British since 1982.

Santisima Trinidad is employed as a flagship.

FLETCHER

OVERVIEW

Hazlewood *(DD 531) after its FRAM conversion showing the flight deck and hangar installed to handle the DASH helicopter drone. Main surface warfare armament is three 127 mm (5 in)/38 Mk 30 in single mounts. Most Fletchers were to this standard when transferred to foreign navies* (Jane's)

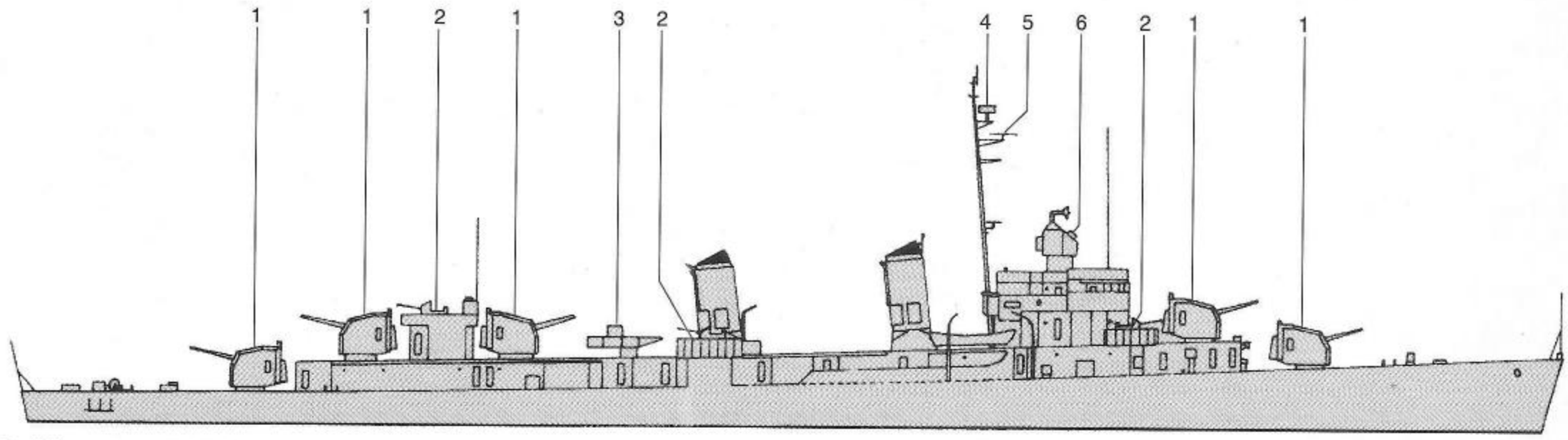
No less than 177 'Fletcher' class destroyers were built between 1942 and 1944 and, of these, four remain in service: one with the Mexican Navy and three with the navy of the Republic of China (Taiwan). The Mexican ship is now primarily employed in drug enforcement duties, while the Taiwanese ships have been transferred to a fishery protection squadron. Nevertheless, all retain a significant armament for anti-ship warfare and shore bombardment and might well be pressed into front-line service in a conflict, and for that reason are included here.

The Fletchers were the first US destroyers to break from the limits imposed by the 1930 London Treaty and a considerable increase in displacement enabled them to mount a heavy armament. By the end of the war they carried five 127 mm (5 in) guns in single turrets and ten 533 mm (21 in) torpedo tubes, together with an air defence armament of five twin 40 mm and seven 20 mm cannon, and six depth charge throwers and two depth charge racks.

They saw extremely active service in the Second World War, during which no less than 19 were sunk. Afterwards, the great majority were placed in reserve in 1945-47, but many of these were returned to front-line duty during the Korean War. Many were transferred to allied navies from the 1950s onwards, while some remained in the US inventory until the early 1970s.

Rowe *(DD 564) in 1965 has received a lesser modification having had one 127 mm (5 in) gun and one bank of five torpedo tubes removed* (H & L van Ginderen Collection)

CUITLAHUAC, MEXICO



Cuitlahuac (Ian Sturton)
1 *127 mm (5 in)/38 Mk 30 single mounts* **2** *Bofors 40 mm/60 Mk 2 twin mounts* **3** *Quintuple 533 mm (21 in) torpedo tubes* **4** *Model 17/9 radar (surface search)* **5** *Model 14/9 radar (navigation)* **6** *Mk 25 GFCS director*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Mexico
Type: US Fletcher

Class: CUITLAHUAC

Purchased: 2
Active: 1

Displacement:
standard: 2,100 t
full load: 3,050 t

Dimensions
Length: 114.8 m (376.5 ft)
Beam: 12 m (39.4 ft)
Draught: 5.5 m (18 ft)

Speed: 32 kts
Range: 5,000 n miles at 14 kts

Complement: 197

SHIPS

CUITLAHUAC (E-01)

Builder	Consolidated Steel Corporation, Orange, Texas, USA
Laid down	25 Jul 1941
Launched	7 May 1942
Commissioned (USA)	9 Feb 1943 (*John Rodgers* (DD 574))
Transferred	Aug 1970

WEAPONS SYSTEMS

TORPEDOES

There is one quintuple launcher for 533 mm (21 in) anti-ship torpedoes.

GUNS

Mk 30 127 mm (5 in) L/38 gun mounting

Cuitlahuac still carries the original armament of five Mk 30 127 mm (5 in) guns. Two are located forward and three aft. The US Navy Mk 30 mounting consists of a single Mk 12 127 mm (5 in), 38 calibre gun with an approximate life of 4,600 EFC (Equivalent Full Charges). The gun and crew are protected by a heavy-gauge steel shield. Shells are loaded manually into a hydraulically powered ramming tray and the crew consists of nine men on the gun and eight in the magazine.

Specifications
(Mk 30)
Calibre: 127 mm (5 in)
Length of barrel: 38 calibres
Muzzle velocity: 792 m/s (new gun), 762 m/s (mid-life) (2,600/2,500 ft/s)
Range: 13.5 n miles (25.26 km)
Altitude: 12,836 m (42,000 ft)
Ammunition: 24.95 kg (55 lb)
Traverse: ±115 to ±165°
Elevation: −15 to +85°
Traverse rate: 29 or 30°/s
Elevation rate: 15°/s
Rate of fire: 20 rds/min

40 mm BOFORS L/60 in US Mk 1 mounting

The ship mounts 10 Bofors 40 mm guns in five twin Mk 1 mountings; two just forward of the bridge screen, two either side of the after stack, and one aft. The mountings are US Navy Mk 1, with two air-cooled guns firing HE-T and HEI-T rounds. The two guns are 243 mm (9 in) apart on the mounting and are slaved in elevation. The two Mk 2 mounts, each with four guns, were removed several years ago).

Specifications
Gun
Calibre: 40 mm
Length of barrel: 56.25 calibres
Muzzle velocity: 881 m/s (new gun); 850 m/s (mid-life) (2,890/2,790 ft/s)
Range: 5.5 n miles (10 km) surface/surface; 6,900 m AA nominal (23,000 ft)
Rate of fire: 80 rds/min (practical); 160 rds/min (cyclic) for water-cooled weapons
Ammunition: 2.21 kg (4,87 lb)
Barrel life: 9,500 EFC (approximately)

Mounting (US Mk 1)
Weight: 4.45-6.76 t
Traverse: 360° at 30°/s
Elevation: −15 to +85/90° at 24°/s
Crew: 4

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Mk 37 GFCS
The Mk 37 Gun Fire Control System (GFCS) is used for the 127 mm guns and is a Second World War vintage system, now only to be seen on elderly ex-US Navy destroyers, such as this. The director incorporates a 4.6 m (15 ft) stereoscopic rangefinder and a Mk 25 H/I-band radar.

Mk 51 GFCS
There are five Mk 51 Gun Fire Control Systems (GFCS), one for each Bofors 40 mm mounting. It includes a Mk 26, E/F-band, range-only radar. Maximum tracking range is 25,000 m.

RADARS

Kelvin Hughes 17/9
The Kelvin Hughes 17/9 is an I-band surface search radar.

Kelvin Hughes 14/9
The Kelvin Hughes 14/9 is an I-band navigation radar.

Western Electric Mk 25
The Western Electric Mk 25 is the H/I-band radar associated with the Mk 37 GFCS.

PROPULSION

Specifications
System: Steam turbines
Main machinery: 4 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 General Electric turbines; 45 MW (60,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The Mexican Navy has traditionally been composed of numerous small ships, with the few large ships being relatively elderly ex-US Navy units. Thus, two 'Fletcher' class destroyers were transferred in August 1970 of which one was discarded in 1982. The survivor, *Cuitlahuac,* has now been in service with the US and Mexican navies for a total of 53 years and appears likely to survive for a few more years yet.

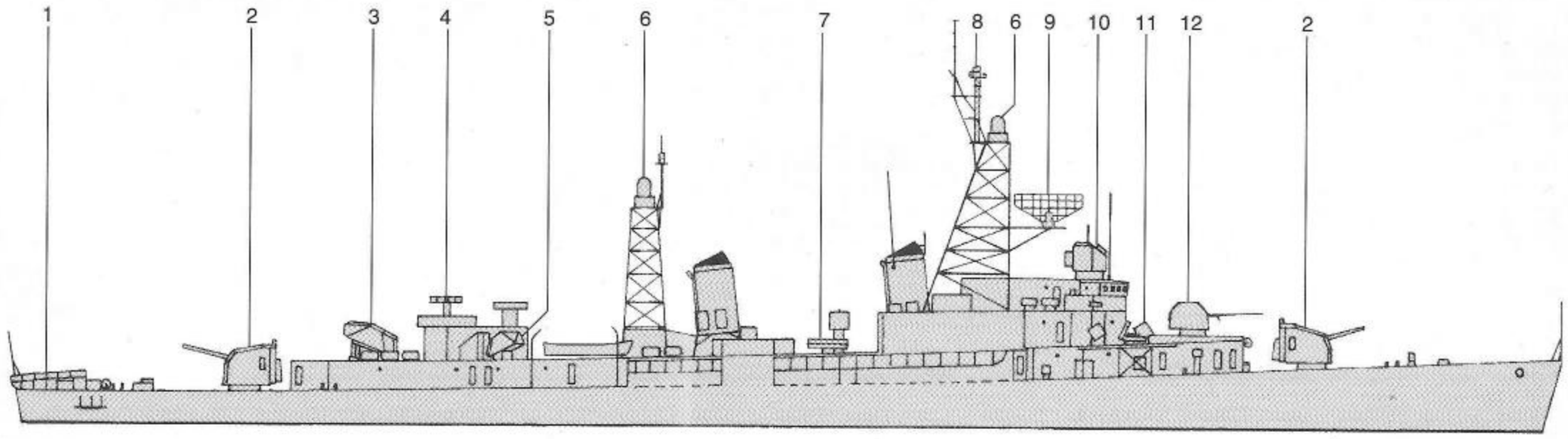
Pennant numbers
This ship originally wore the number F-2 on transfer to the Mexican Navy, but this was later changed to E-02, and subsequently to the current E-01.

DEPLOYMENT

All of the original ASW armament has been removed, as has most of the electronic gear, and speed is now reduced to some 12 knots. Nevertheless, the ship retains a basic surface warfare capability, and its gun armament of five 127 mm and ten 40 mm weapons is formidable, enabling the ship to play a useful role in drug enforcement patrols.

Cuitlahuac *(E-01) was launched in May 1942 as USS* John Rodgers *(DD 574) and is still in service 54 years later. The ship's appearance has changed remarkably little, even to the retention of the five 127 mm (5 in) turrets* (Julio Montes)

KWEI YANG, Taiwan



Kwei Yang (Ian Sturton)
1 *Depth charge rack* **2** *127 mm (5 in)/38 Mk 30 single mount* **3** *Triple Hsiung Feng SSM launcher* **4** *Four-arm Sea Chaparral launcher (Sidewinder missiles)* **5** *Single Hsiung Feng SSM launcher* **6** *HR-76 fire director (SAM and guns)* **7** *Triple Mk 32 324 mm torpedo launcher* **8** *SPS-58 radar (air/surface search)* **9** *SPS-40 radar (air search)* **10** *Mk 37 GFCS director (includes H-930 radar, Kollmorgen electro-optical sight)* **11** *Hedgehog Mk 10 ASW mortar* **12** *OTOBREDA 76 mm (3 in)/62 Compact single mount*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Taiwan
Type: US Fletcher

Class: KWEI YANG

Purchased: 4
Active: 3

Displacement:
standard: 2,100 t
full load: 3,050 t

Dimensions
Length: 114.8 m (376.5 ft)
Beam: 12 m (39.4 ft)
Draught: 5.5 m (18 ft)

Speed: 35 kts
Range: 3,750 n miles at 14 kts

Complement: 261 *(Kwei Yang);* 270 (remainder)

SHIPS

KWEI YANG (908)		**AN YANG** (918)		**KUN YANG** (919)	
Builder	Bethlehem Steel, San Francisco, USA	**Builder**	Bethlehem Steel, Staten Island, USA	**Builder**	Bethlehem Steel, San Francisco, USA
Laid down	20 Nov 1942	**Laid down**	27 Jul 1942	**Laid down**	5 Dec 1942
Launched	11 Jul 1943	**Launched**	4 Feb 1943	**Launched**	25 Jul 1943
Commissioned (US Navy)	1 Dec 1943 (*Twining* (DD 540))	**Commissioned (US Navy)**	22 May 1943 (*Kimberly* (DD 521))	**Commissioned (US Navy)**	30 Dec 1943 (*Yarnall* (DD 541))
Sold to Taiwan	16 Aug 1971	**Transferred on loan**	2 Jun 1967	**Transferred on loan**	10 Jun 1968
		Sold to Taiwan	25 Jan 1974	**Sold to Taiwan**	25 Jan 1974

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Hsiung Feng IA short/medium-range anti-ship missile

There are five Hsiung Feng launchers: one triple unit in 'C' gun position facing aft and two single units some 3 m further forward and facing forward. Hsiung Feng IA is a short-range anti-ship missile, derived from the Israeli Gabriel, and is powered by a turbojet cruise engine, with rocket boosters for take-off. The fire-control system is similar to that used in Gabriel with a radar tracker (usually HR 76), a display control and processing unit, a vertical reference unit and an optical sight which is usually the Kollmorgen Mk 35 or Model 985. The launcher-containers are also identical to those used in Gabriel and are generally similar to the Harpoon's Mk 141.

The target is acquired by long-range surface search radars with over-the-horizon targeting facilities through a Ta Chen datalink. The launcher and target locations are inserted into the inertial guidance system, the missile is launched and adopts a low-level cruising altitude. The target is acquired by both the radar and the IR sensors and the returns are compared with an onboard library. If significant deviations in one sensor's returns occur then the guidance system assumes it is being jammed and gives priority to the other as the missile enters the sea-skimming terminal phase.

Specifications
(Hsiung Feng IA)
Length: 3.9 m
Diameter: 34 cm
Wing span: 1.35 m
Weight: 540 kg
Speed: Mach 0.9
Range: 19 n miles (36 km)
Guidance: Semi-active radar and manual
Warhead: 150 kg HE
Engine: Microturbo TRI-60 single spool turbojet

Loral RIM-72C Sea Chaparral

One quadruple Sea Chaparral launcher is sited immediately forward of the triple Hsiung Feng battery. The Sea Chaparral system consists of a manned Mk 54 mounting with two rails on each side, each carrying a single Sidewinder SAM. In addition to the four missiles on the mounting there are 16 reloads in a magazine. The rails elevate from −9 to +90°.

The Sidewinder missile has an all-aspect IR seeker, a blast fragmentation warhead, and is powered by a single-stage, solid propellant rocket motor. The operator sits in an air conditioned cab with controls for activating the system, selecting the missile and initiating the launch sequence. Early warning of the target is provided by the ship's radar and the CIC tells the operator the direction in which he should turn the mounting. Having acquired the target optically, he tracks it and selects and activates a missile for the engagement. When the missile's IR detector has acquired the target an audio tone sounds and the operator launches the missile. Proportional navigation guidance commands are generated from seeker tracking rates and used to control the missile's flight path.

The RoC Navy is the only operator of this system.

Specifications
Length: 2.91 m (9.55 ft)
Diameter: 12.7 cm (5.0 in)
Wing span: 63 cm (24.8 in)
Weight: 86.2 kg (190 lb)
Speed: Mach 1.2
Range: 4.75 n miles (9 km)
Guidance: Optical aiming, infra-red homing
Warhead: Picatinny Arsenal M-250 12.6 kg (27.77 lb) HE blast fragmentation
Motor: Hercules/Atlantic Research Corporation M-121 single-stage, solid propellant rocket motor

Manufacturer/Contractor
Loral, Aeronutronic.

TUBES

Six 324 mm US 32 torpedo tubes are sited in two triple

mounts on either beam in the gap between the two stacks.

Specifications
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

Alliant Techsystems Mk 46 Mod 5 324 mm torpedoes

Specifications
Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507.0 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

GUNS

Mk 30 127 mm (5 in) L/38 gun mounting
All three units have had two of the original five 127 mm mountings removed in order to create space for the Hsiung Feng and Sea Chaparral launchers. At least one *(Kwei Yang)* of the three has had a third mounting removed from 'B' position and replaced by an OTOBREDA 76 mm mounting, but whether this has happened in the other two cases is not clear.

The US Navy Mk 30 mounting consists of a single Mk 12 127 mm (5 in), 38 calibre gun with an approximate life of 4,600 EFC (Equivalent Full Charges). The gun and crew are protected by a heavy-gauge steel shield. Shells are loaded manually into a hydraulically powered ramming tray and the crew consists of nine men on the gun and eight in the magazine.

Specifications
(Mk 30)
Calibre: 127 mm
Length of barrel: 38 calibres
Muzzle velocity: 792 m/s (new gun), 762 m/s (mid-life)
Range: 13.5 n miles (25.26 km)
Altitude: 12,836 m
Ammunition: 24.95 kg
Traverse: ±115 to ±165°
Elevation: -15 to +85°
Traverse rate: 29 or 30°/s
Elevation rate: 15°/s
Rate of fire: 20 rds/min

OTOBREDA 76 mm (3 in)/62 Compact
As described above, at least one ship *(Kwei Yang)* has 'B' 127 mm turret replaced by an OTOBREDA 76 mm Compact mounting, as has also been done in most of the 'Gearing' class Wu Chin conversions.

Specifications
(Compact)
Calibre: 76.2 mm (3.0 in)
Length of barrel: 4.72 m (15.49 ft)
Training: 360° at 70°/s
Elevation: -15 to +85° at 40°/s
Muzzle velocity: 900 m/s (2,953 ft/s)
Max rate of fire: 85 rds/min
Range: 8.6 n miles (16 km)

ANTI-SUBMARINE MORTARS

Projector Mk 10 (Hedgehog)
Despite their age, two Hedgehog anti-submarine spigot mortars are retained, sited just forward of the bridge screen. Each mounting holds 24 rounds in four vertical rows each of six, with an electric motor giving the spigots a traverse of 25° as well as compensating for roll. The mounting fires the bombs into a circular pattern with a 41 m (134 ft) radius at a range of 230-250 m.

Specifications
Projectile
Diameter: 177.8 mm (7 in)
Weight: 29.5 kg (65 lb)
Fuze: Impact
Explosive weight: 13.6 kg (30 lb)
Sinking speed: 7.6 m/s (25 ft/s)

DEPTH CHARGES

These ships retain a single Mk IX depth charge rack, for which 12 depth charges are carried.

MINES

There is one mine rail aft.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

Argo 680/681
There is an Argo AR-680/681 intercept and jammer suite.

Kung Feng-6 chaff launchers
All three ships are fitted with four Kung Feng-6 16-barrelled chaff launchers.

COMMAND AND CONTROL SYSTEMS

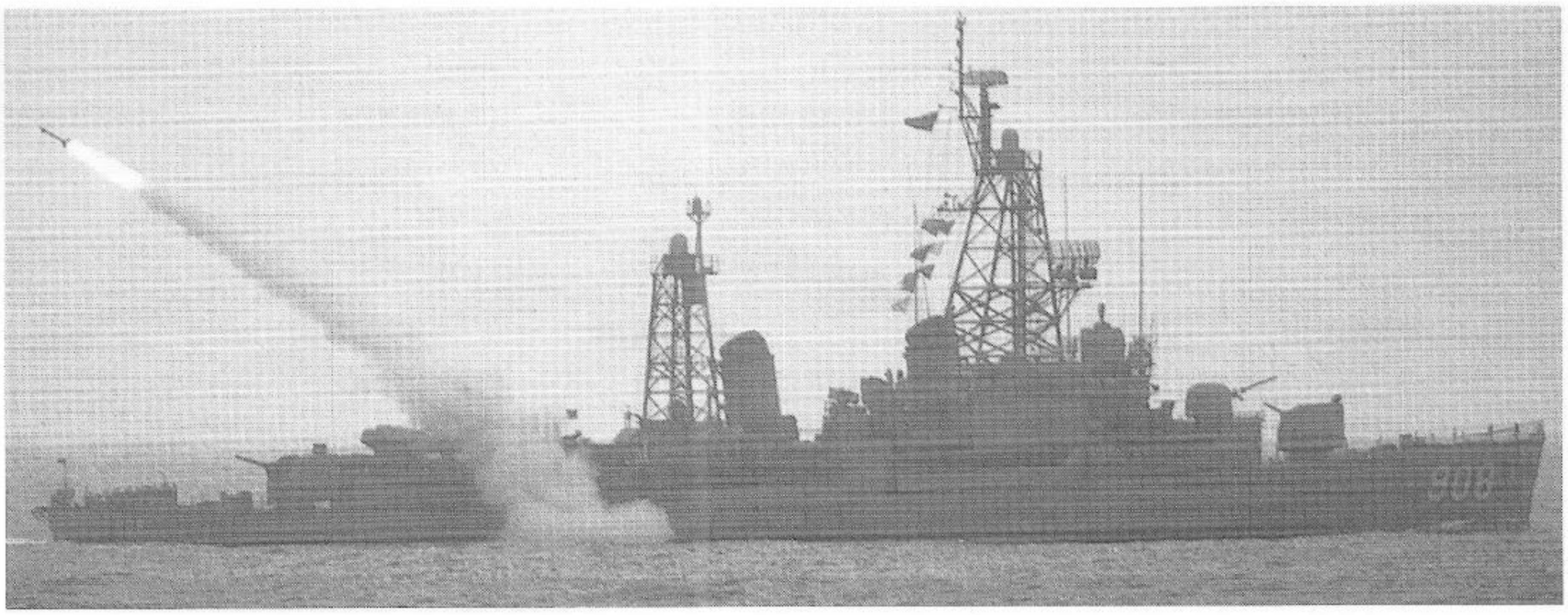
WEAPONS CONTROL

Hughes H-930 Mod 1 command and weapon control system
The H-930 Mod 1 command and weapon control system interfaces with guns and missiles and has a federated architecture based on Rolm AN/UYK-19 (Model 1664) mini-computers which are housed in the display consoles and linked by a databus. Software uses the Algol language and there are some 30,000 lines of code. The sensor combinations associated with Mod 1 are as follows:

air search radar; AN/SPS-58
surface search radar: AN/SPS-40
two fire-control radars: HR-76
optical director: Mk 35

There are two pairs of fire-control/radar search consoles each controlling a fire-control radar and two or three gun mountings. One also interfaces with the search radar, which share a common antenna, while the other interfaces with the ESM system and the Mk 35 optical director. The two are linked by a databus and the whole system interfaces with an Elbit tactical data handling system.

Manufacturer/Contractor
Hughes Simulation International Inc, Training and Support Systems Group.



Kwei Yang *(908) launches a Sidewinder missile. These elderly 'Allen M Sumner' class ships have been regularly modernised by the RoC Navy, the latest additions being Hsiung Feng anti-ship missiles, the Sea Chaparral air defence system and an OTOBREDA 76 mm gun in 'B' position*

Mk 37 GFCS

The Mk 37 Gun Fire Control System (GFCS) is used for the 127 mm guns and is a Second World War vintage system, now only to be seen on elderly ex-US Navy destroyers, such as this. The director incorporates a 4.6 m (15 ft) stereoscopic rangefinder, a Mk 25 H/I-band radar, and a Kollmorgen electro-optical sight.

SONAR

DSQS-21CZ hull-mounted and variable depth sonar systems

DSQS-21CZ has a 1 m diameter hull-mounted, medium-frequency transducer array, with 32 preformed beams. It uses computer-aided detection techniques for classification and tracking and the information is presented on colour CRT displays to permit Doppler coding and the discrimination of data on the integrated displays. The sonar system can automatically transmit up to 10 targets directly into SATIR.

(Note: The 'Z' in the designation indicates a variant equipped with electronic stabilisation to minimise the effects of ship's motion)

Manufacturer/Contractor

STN Atlas Elektronik GmbH, Bremen, Germany.

RADARS

Set	AN/SPS-40	AN/SPS-58	Two HR-76
Company	Lockheed	Westinghouse	RCA
Role	Air search	Air/surface search	Fire control
Band	E/F	D	I
Range	175 n miles (320 km)		1 m² target 21.5 miles (40 km)
Beam	1.5 × 16°	6 × 12°	2.7°
Peak power	500 kW	12 kW	250 kW
Gain	30 dB	26 dB	32 dB
Pulsewidth	0.25/1.3 µs	5 µs	0.25/0.5/1.0 µs
PRF	650 pps	2,290/3,050 pps	1,000-3,000 pps
Scan rate	15 rpm	20 rpm	–

PROPULSION

Specifications

System: Steam turbine

Main machinery: 4 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 General Electric/Allis Chalmers/Westinghouse turbines; 45 MW (60,000 hp)

Shafts: 2

FURTHER INFORMATION

PROGRAMME

Four 'Fletcher' class ships were acquired from the United States: *An Yang* (918) – 1967; *Kun Yang* (919) – 1968; and *Kwei Yang* (908) and *Chiang Yang* (947) in 1971. They were front-line units in the RoC Navy for many years and were repeatedly modernised. *Chiang Yang* (947) was deleted in 1994, but the other three were transferred to fishery protection duties in 1995, although they would doubtless be returned to front-line service in the event of a conflict, particularly with the People's Republic of China.

MODERNISATION

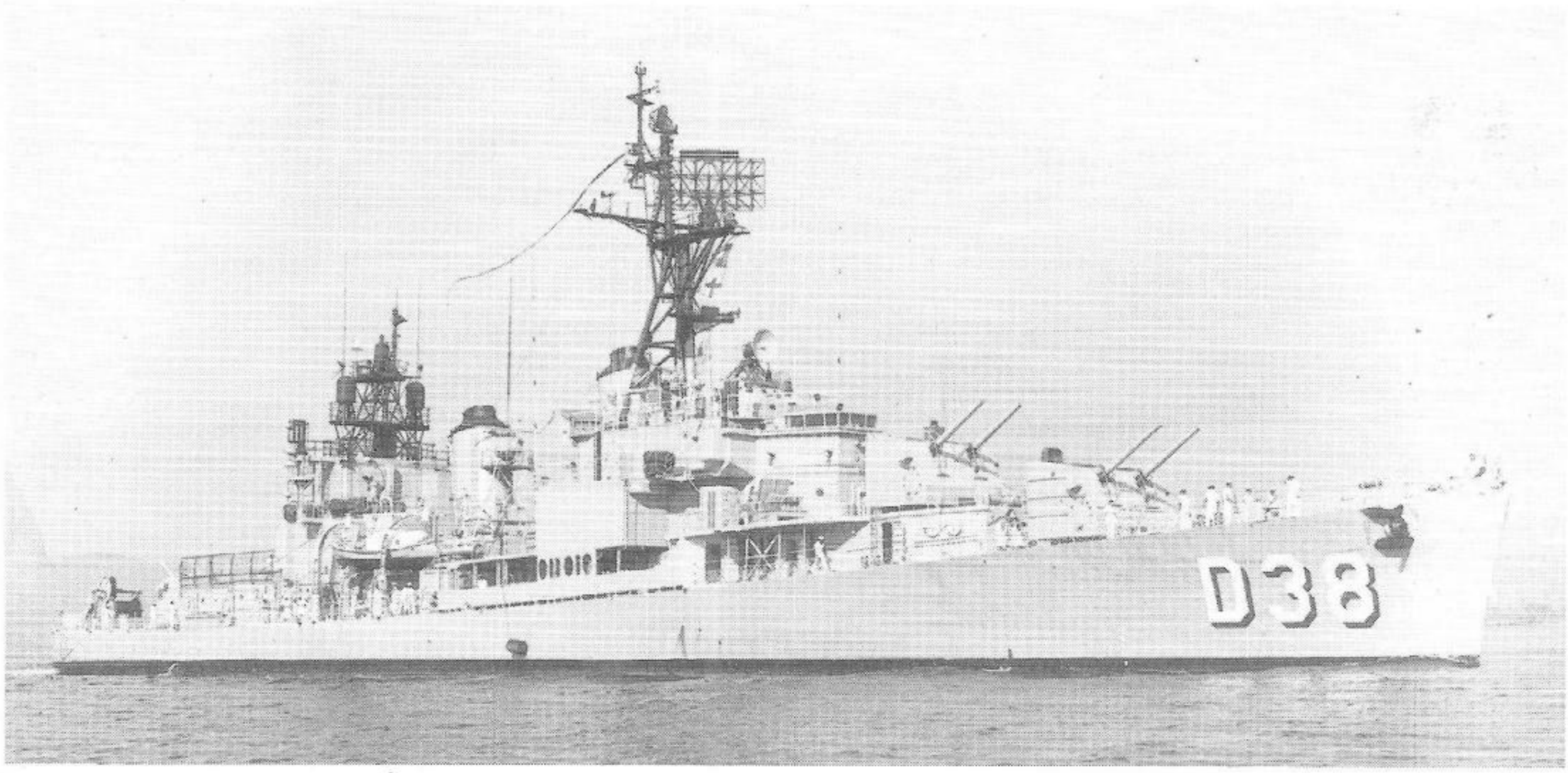
The armament fit was modernised under the Wu Chin I programme. *Kun Yang* can act as a minelayer.

OPERATIONAL

All are to be scrapped when the second batch of three 'Knox' class are fully operational.

ALLEN M SUMNER

OVERVIEW



Of the 58 'Allen M Sumner' class destroyers built, four were lost in the war and, after a long period of post-war service with the US Navy, 29 were sold to foreign navies. The picture shows the Brazilian Espirito Santo *(D 38) which served in the Brazilian Navy from 1973 to 1975. The 'Allen M Sumner' class was the first US destroyer class to mount the twin 127 mm (5 in) Mk 38 turret, two of which can be seen in 'A' and 'B' positions* (Jane's)

Fifty-eight 'Allen M Sumner' class destroyers were launched between December 1943 and October 1944. They used virtually the same hull as the previous 'Fletcher' class, but their main armament was the then new twin 127 mm (5 in) gun in a closed turret. The designers made great efforts to create extra deck space, particularly on the centreline, but that space was rapidly taken up in operational theatres by an ever-growing number of anti-aircraft weapons. The growing weight required more power, which the Sumners did not have, so the longer and more powerful 'Gearing' class was produced.

Four were lost in the war and the survivors served in the US Navy until the late 1960s when sales to foreign navies began. 29 were sold abroad and of these just three survive.

The Taiwanese ship, *Nan Yang,* has been converted under that navy's Wu Chin programme and is now virtually indistinguishable from similar conversions based on Gearing hulls. It is, therefore, described in the Wu Chin entry.

TABLE 1: SUMNER CLASS IN SERVICE 1997

Country	In service	Current Name	Former name
Iran	2	*Babr* (61) *Palang* (62)	*Zellers* (DD 777) *Stormes* (DD 780)
Taiwan	1	*Nan Yang* (917)	*John W Thomas* (DD 760)
TOTAL	**3**		

GENERAL SPECIFICATIONS

(as built)

Operator: USA

Class: 'ALLEN M SUMNER'

Built: 58
Active: 3

Displacement:
standard: 2,610 t
full load: 3,218 t

Dimensions
Length: 114. 8 m (376.5 ft)
Beam: 12.5 m (41 ft)
Draught: 6.5 m (21.4 ft)

Speed: 34 kts
Range: 3,740 n miles at 12.5 kts

Complement: 290 (14 officers)

WEAPONS SYSTEMS

TUBES

Ten 533 mm (21 in) tubes.

GUNS

Six 127 mm (5 in)/38 (three twin) Mk 38
12–40 mm (two quad, two twin)
11–20 mm.

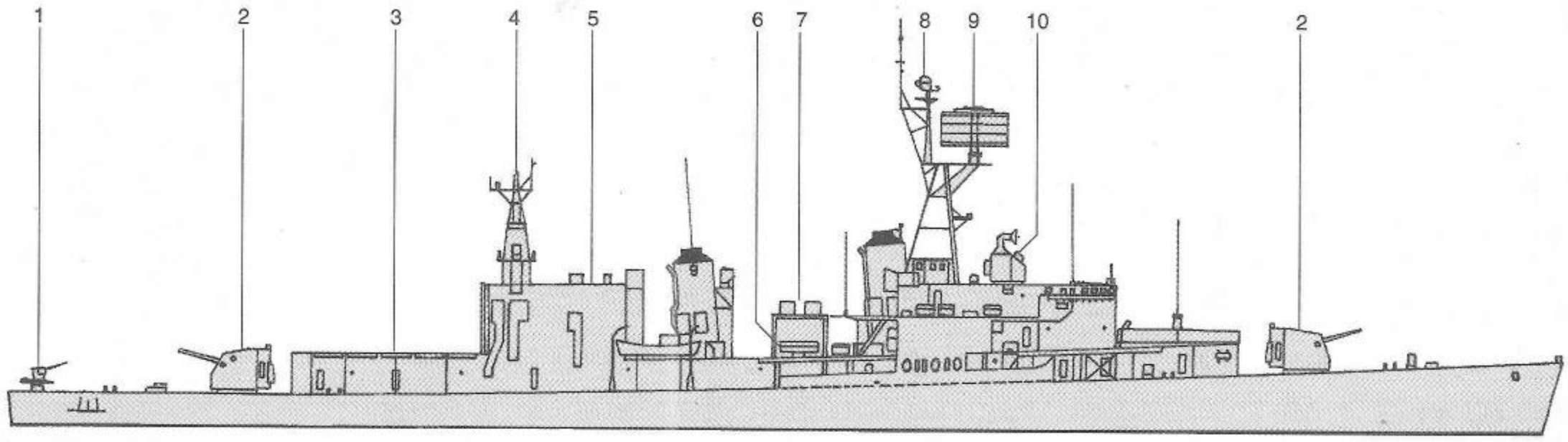
DEPTH CHARGES

6 throwers, 2 racks.

PROPULSION

Specifications
System: Steam turbine
Main machinery: 4 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 turbines; 45 MW (60,000 shp)
Shafts: 2

BABR (ALLEN M SUMNER)



Babr (Ian Sturton)
1 *Twin 23 mm cannon* **2** *Twin 127 mm (5 in)/38 Mk 38 mounting* **3** *Flight deck* **4** *ULQ-6 ESM/ECM* **5** *Hangar (with telescopic extension)* **6** *Triple Mk 32 324 mm torpedo launcher* **7** *Standard SM-1MR box launchers (four)* **8** *SPS-10B radar (surface search)* **9** *SPS-29C radar (air search)* **10** *Mk 25 fire-control director*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Iran
Type: Allen M Sumner

Class: BABR (FRAM II)

Purchased: 2
Active: 2

Displacement:
standard: 2,388 t
full load: 3,254 t

Dimensions
Length: 114.8 m (376.5 ft)
Beam: 12.5 m (41 ft)
Draught: 6.5 m (21.4 ft)

Speed: 34 kts
Range: 3,740 n miles at 12.5 kts

Complement: 290 (14 officers)

SHIPS

BABR (61)

Builder	Todd Pacific Shipyards, Seattle, Washington, USA
Laid down	24 Dec 1943
Launched	19 Jul 1944
Commissioned (US Navy)	25 Oct 1944 (*Zellers* (DD 777))
Transferred by sale	19 Mar 1971

PALANG (62)

Builder	Todd Pacific Shipyards, Seattle, Washington, USA
Laid down	15 Apr 1944
Launched	4 Nov 1944
Commissioned (US Navy)	27 Jan 1945 (*Stormes* (DD 780))
Transferred by sale	16 Feb 1972

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Standard Missile-1 Medium Range (SM-1MR)

These two destroyers each carry four launchers for GDC Pomona RIM-66B Standard SM-1MR missiles. These are in unusual box launchers, mounted between the two stacks, with each pair pointing across the ship to fire over the opposite side, an arrangement more usually found with Harpoon missiles. The reason for this mounting is that the missiles are primarily intended to be used in the anti-ship role, with only a secondary anti-aircraft role, a complete reversal of the normal priorities. The missile is not, however, a RIM-66D, which would be able to home on the target's radar emissions, but a normal RIM-66B, which means that the limiting factors are the Mk 37 fire-control system and its Mk 25 radar, which carry out the engagements and effectively limit anti-ship engagements to horizon range.

The Standard SM-1MR is the original version of the missile with a combined booster-sustainer rocket motor. The missile has a Raytheon conical scan, solid-state, semi-active radar seeker with scan receiver, speed gate and analogue guidance computer. It is likely that the availability of this system is low due to shortage of spares.

Specifications
(SM-1MR)
Length: 4.46 m (14.66 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.57 m (5.15 ft)
Weight: 1,343.6 kg (2,962 lb)
Speed: Mach 2.5
Range: 34.5 n miles (64 km)*
Altitude: 24,400 m (80,000 ft)

*Limited by fire-control arrangements to the horizon.

Manufacturers/Contractors
Hughes Missile Systems.
Raytheon Missile Systems Division.

GUNS

Mk 30/38 127 mm (5 in) L/38 gun mounting

There are two Mk 38 twin 127 mm mountings in 'A' and 'B' positions. The Mk 38 mountings use two Mk 12 guns, with shells being loaded manually into a hydraulically powered ramming tray. The mounting is worked in manual, local or remote control. With automatic control it is operated by a remote fire-control system by means of indicator regulators on the single training gear assembly and the single elevating assembly. Each gun has its own projectile and propellant hoists, with the projectile hoist lift pawls also acting as fuze setters. The mounting requires 13 men within the armoured shield and 14 in the magazines. The approximate life of each barrel is 4,600 EFC (Equivalent Full Charges).

Specifications
Calibre: 127 mm
Length of barrel: 38 calibres
Muzzle velocity: 792 m/s (new gun), 762 m/s (mid-life)
Range: 13.5 n miles (25.26 km)
Altitude: 12,836 m
Weight of shell: 24.95 kg
Traverse: ±164° at 25°/s
Elevation: −15 to +85° at 15°/s
Rate of fire: 36 rds/min

23 mm/80 calibre twin cannon

These ships do not have the Bofors 40 mm or Oerlikon 20 mm cannon found in most other ex-US Navy destroyers, but have, instead, a single twin 23 mm mounting situated right aft. This appears to be similar to the Russian ZSU-23-2 mounting.

Specifications
(ZSU-23-2)
Calibre: 23 mm
Length of barrel: 870 calibres
Traverse: 360°
Elevation: −10 to +85°
Rate of fire (per barrel): 200 rds/min (practical)
Projectile: 0.19 kg HEI-T
Range:
anti-surface: 1.1 n miles (2.0 km)
AA: 1,500 m
Torpedoes: 6—324 mm Mk 32 (2 triple) tubes. Possibly Honeywell Mk 44 or 46

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

AN/WLR-1

AN/WLR-1 is a US-manufactured, manually operated, radar warning system covering frequencies from 50 MHz to 10.75 GHz, employing a number of separate antennas.

ULQ-6

ULQ-6 is a deception jammer which was originally developed to deal with the threat posed by Soviet missiles such as SS-N-2.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Mk 37 GFCS

In these Iranian ships the Mk 37 Gun Fire Control System (GFCS) has been adapted so that it can be used for both the 127 mm guns and the Standard SM-1MR missiles. It is a Second World War vintage system, now only to be seen on elderly ex-US Navy destroyers, such as these. The director incorporates a 4.6 m (15 ft) stereoscopic rangefinder and a Mk 25 H/I-band radar.

Mk 105 Torpedo Fire Control System

The Mk 105 Torpedo Fire Control System (TFCS) was a system installed in US Navy ASW destroyers in the 1940s and 1950s; the version in these two Iranian ships is probably either Mod 21 or Mod 22. Basic elements of the system are an attack director, torpedo director, angle solver, co-ordinate converter and a computer. It is used to control ASW weapons, which, as the ships are now armed, means the torpedo tubes.

IFF

UPX-1/UPX-12.

RADARS

Set	AN/SPS-29C	AN/SPS-10B	LN-66	Mk 25 (Mk 37 GFCS)
Company	Westinghouse	Raytheon/Sylvania	Canadian Marconi	Western Electric
Role	Air search	Surface search	Navigation	Fire control
Band	A/B	G	I/J	I/J
Range	250 n miles (457 km)	—	—	91,000 m
Beam	19 × 25.5°	1.5 × 16°	2.5 × 22°	1.6°
Peak power	750 kW	500 kW	75 kW	250 kW
Gain	18 dB	30 dB	—	39 dB
Pulsewidth	10 µs	0.25/1.3 µs	1.0/0.1 µs	0.25 µs
PRF	300 pps	650 pps	500/2,000 pps	1,320 pps
Scan rate	7.5/15 rpm	15 rpm	22 rpm	—

SONAR

AN/SQS-43 and AN/SQS-44

AN/SQS-43 is fitted in *Babr* and AN/SQS-44 in *Palang*. Historically, AN/SQS-43 is a modified version of AN/SQS-29B, which, in turn, was a modified version of AN/SQS-4 Mod 1, while AN/SQS-44 was derived from AN-SQS-4 Mod 2 via AN/SQS 30. Both Iranian sets are hull-mounted, active search and attack sonars, operating at medium and high frequencies. Both sets are capable of working with a VDS and an AN/SQA-10 system was installed in the Iranian ships at the time of delivery, although it has subsequently been removed.

Iranian Navy destroyer Palang *(62); the full pennant number has since been repainted on the bow. These two ships are unusual in that they are armed with Standard SM-1MR missiles optimised for the anti-ship role. Note also the telescopic hangar for the AB 204AS shipboard helicopter*

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 14.4 × 12 m (47 × 40 ft)
Hangar: Telescopic hangar (see 'Design' below)

HELICOPTERS

Agusta-Bell AB 204AS

Specifications
Dimensions
Rotor diameter: 14,63 m (48.0 ft)
Fuselage length (rotors turning): 17.37 m (57.0 ft)
Height: 3.84 m (12.60 ft)
Weights:
operating, empty: 2,939 kg (6,480 lb)
max take-off: 4,309 kg (9,500 lb)

Performance:
max speed: 104 kts (193 km/h)
service ceiling: 3,200 m (10,500 ft)
max cruising speed (sea level): 90 kts (167 km/h)
operational radius: 60 n miles (110 km)
Power plant: 1 General Electric T56-GE-3 rated at 962 kW (1,290 shp)
Crew: 3, pilot, co-pilot, sensor operator
Sensors: AQS-13B dunking sonar
Typical weapon loads: 2 Mk 44 or Mk 45 homing torpedoes or 4 AS.12 anti-ship missiles

PROPULSION

Specifications
System: Steam turbines
Main machinery: 2 Babcock & Wilcox and 2 Foster-Wheeler boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 General Electric turbines; 45 MW (60,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

These two Allen M Sumner FRAM II conversions were purchased from the US Navy in 1971/72 and both underwent a major and lengthy refit at the Philadelphia Navy Yard, before sailing to their new home in 1974.

MODERNISATION

Both ships received a full refit as well as conversion at Philadelphia NSY before sailing for Iran. This included a much-improved air conditioning layout and altered accommodation, making them more suitable for the hot and dusty environment in which they would operate. 'B' gun mount with its magazine was removed and replaced by two Hedgehogs. Midships, four Standard SM-1MR launchers were installed, but as noted above, these are intended for surface-to-surface rather than surface-to-air engagements. Further aft, the DASH flight deck was enlarged and a telescopic hangar, similar to that used in the Canadian 'Annapolis' and US Navy 'Knox' class frigates, installed. Finally, an AN/SQA-10 variable depth sonar was installed.

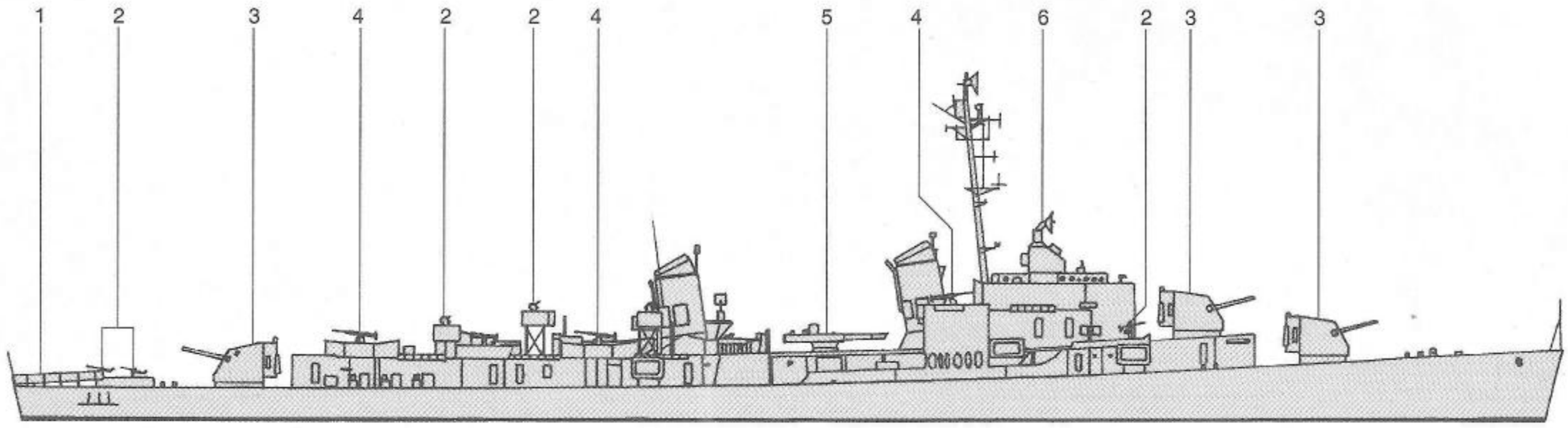
During their time in Iranian service the ships have undergone a number of modifications, at least some of which have been necessitated by the refusal of the United States to supply spare parts. The modifications include the removal of Hedgehog and the VDS, and the fitting of a twin 23 mm mounting right aft.

OPERATIONAL

Both ships were reported to be conducting regular patrols up to 1995, but recently only *Palang* has been seen at sea. At one time the second digit of the pennant numbers was painted out, apparently in an attempt to make identification more difficult, but the full numbers have since been restored.

GEARING/CARPENTER

OVERVIEW



Gearing (1945) (Ian Sturton)
1 *Depth charge rails* **2** *Oerlikon 20 mm cannon* **3** *Twin 127 mm (5 in)/38 Mk 38* **4** *Bofors 40 mm cannon* **5** *Ten 533 mm (21 in) torpedo tubes* **6** *Mk 37 gunfire control system*

'Gearing' class

No less than 34 of the Second World War 'Gearing' and 'Carpenter' class destroyers remain in service 50 years after they were built for the US Navy, a major tribute to the soundness of the design and the excellence of their construction. The 'Gearing' class was the final development of the US Navy's wartime destroyers and was generally similar to the 'Allen M Sumner' class, 58 of which were completed between 1943 and 44. The Gearing hull was 4.27 m (14 ft) longer enabling some 240 t more fuel to be carried, thus increasing range from 3,300 n miles to 4,500 n miles, while improved hull design enabled increased maximum speed.

Of the 116 ordered, 93 were completed to the original general purpose destroyer design. A further four were completed after the war to a modified design as anti-submarine escorts and are known as the 'Carpenter' class (see below). In response to the changing requirements of the Pacific campaign, 24 were converted in 1945 to become radar pickets, designated DDR, while the others were being given a third quadruple 40 mm mounting to replace the after quintuple torpedo tubes in response to Japanese kamikaze attacks. With the start of the Cold War confrontation most Gearings were converted to ASW ships to counter the fast Soviet submarines that were expected, particularly in the North Atlantic.

In the late 1950s, 77 Gearings underwent the Fleet Rehabilitation and Modernisation I (FRAM I) programme, which was designed to extend their useful lives and to optimise them for the ASW role. The conversion involved removing one 127 mm (5 in) turret (No 3 gunhouse in the case of the first eight, No 2 gunhouse for the remainder) as well as all 40 mm and 20 mm weapons, and the installation of an SQS-23 long-range sonar, ASROC launcher, and triple ASW torpedo tubes. In addition, a DASH helicopter was carried, which required a relatively small hangar and a flight deck.

Sixteen other Gearings were converted to FRAM II standard in which a new bridge was fitted, together with new radar and ECM equipment. The original AN/SQS-4 sonar was retained, but moved forward and its performance enhanced, and two triple Mk 32 and two fixed 533 mm (21 in) torpedo tubes installed between the stacks. A flight deck and hangar for the DASH helicopter system were also installed.

At the end of their lives with the US Navy some Gearings were stricken from the US register and either scrapped locally, expended as targets, or, in the case of the former *Joseph P Kennedy Jr* (DD 850), preserved as a memorial. No less than 56 were sold abroad from 1971 onwards going to Argentina (1), Brazil (2), Ecuador (1); Greece (9); South Korea (7); Mexico (2); Pakistan (4); Spain (5); Taiwan (14) and Turkey (11). Some of these have been scrapped, but a remarkable 33 remain in fleet service with 7 navies (see below), most of which have been further modified since leaving US service.

'Carpenter' class

Four 'Gearing' class ships were completed after the war's end as specialised ASW ships: *Epperson* (DD 719); *Basilone* (DD 824); *Carpenter* (DD 825); and *Robert A Owens* (DD 827). They were known collectively as the 'Carpenter' class, although the differences between them and the Gearings were relatively small and grew less when the latter underwent the FRAM modernisation programme.

Basilone (DD 824) was scrapped in 1977 but the other three remain in service. *Epperson* (DD 719) was transferred to Pakistan in 1977 and renamed *Taimur,* while *Carpenter* (DD 825) and *Robert A Owens* (DD 827) went to Turkey.

CURRENT DISPOSITION

Country	In service	Current name	Former name
Greece	2	*Kountouriotis*	*Rupertus* (DD 851)
		Tompazis	*Gurke* (DD 783)
South Korea	7	*Chung Buk*	*Chevalier* (DD 851)
		Jeon Buk	*Everett F Larson* (DD 830)
		Taejon	*New* (DD 818)
		Kwang Ju	*Richard E Kraus* (DD 849)
		Kang Won	*William D Rush* (DD 714)
		Kyong Ki	*Newman K Perry* (DD 883)
		Jeon Ju	*Rogers* (DD 876)
Mexico	2	*Ilhuicamina*	*Vogelgesang* (DD 862)
		Netzahualcoyotl	*Steinaker* (DD 863)
Pakistan	3	*Alamgir*	*Cone* (DD 866)
		Taimur	*Epperson* (DD 719)
		Tughril	*Henderson* (DD 785)
Taiwan	14	*Lao Yang*	*Shelton* (DD 790)
		Fu Yang	*Ernest G Small* (DD 838)
		Shuei Yang	*Hawkins* (DD 873)
		Dang Yang	*Lloyd Thomas* (DD 764)
		Han Yang	*Herbert J Thomas* (DD 833)
		Lai Yang	*Leonard F Mason* (DD 852)
		Kai Yang	*Richard B Anderson* (DD 786)
		Chien Yang	*James E Kyes* (DD 787)
		Liao Yang	*Hanson* (DD 832)
		Shen Yang	*Hollsiter* (DD 788)
		Te Yang	*Sarsfield* (DD 837)
		Yun Yang	*Johnston* (DD 821)
		Chen Yang	*Power* (DD 839)
		Shao Yang	*Hamner* (DD 718)
Turkey	6	*Yucetepe*	*Orleck* (DD 886)
		Kilic Ali Pasha	*Robert H McCard* (DD 822)
		Piyale Pasha	*Fiske* (DD 842)
		Gayret	*Eversole* (DD 789)
		Anitepe	*Carpenter* (DD 825)
		Alcitepe	*Robert A Owens* (DD 827)
TOTAL	**34**		

US Navy destroyer Agerholm *(DD 826) 'Gearing' class ship following its FRAM I conversion in the early 1960s. This was intended to produce fast, long-range ASW ships and the weapons included an ASROC launcher (between the stacks) and the DASH helicopter drone which was provided with a large flight deck and a hangar. Anti-aircraft armament was minimal but four 127 mm (5 in) guns gave a limited anti-surface and shore bombardment capability* (Jane's)

GENERAL SPECIFICATIONS

(as built)

Displacement:
standard: 2,616 t
full load: 3,460 t

Dimensions
Length: 116 m (383 ft)
Beam: 12.5 m (40.8 ft)
Draught: 4.4 m (14.3 ft)

Speed: 36.8 kts
Range: 4,500 n miles at 20 kts

Complement: 336

WEAPONS SYSTEMS

TUBES

Ten 533 mm (21 in) tubes.

GUNS

Six 127 mm (5 in)/38 (two twin) Mk 38.
12–40 mm (two quad, two twin).
11–20 mm.

DEPTH CHARGES

Six throwers, two racks.

Robert A Owens *(DD 827) was one of four 'Carpenter' class ships completed for the US Navy; they were essentially the first ASW conversions of the 'Gearing' class design. No less than three of the four 'Carpenter' class ships completed in 1946 are still in service in 1997, including* Robert A Owens, *now the Turkish Navy's* Alcitepe *(D 346)* (H & L van Ginderen Collection)

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Mk 37 GFCS.

SONARS

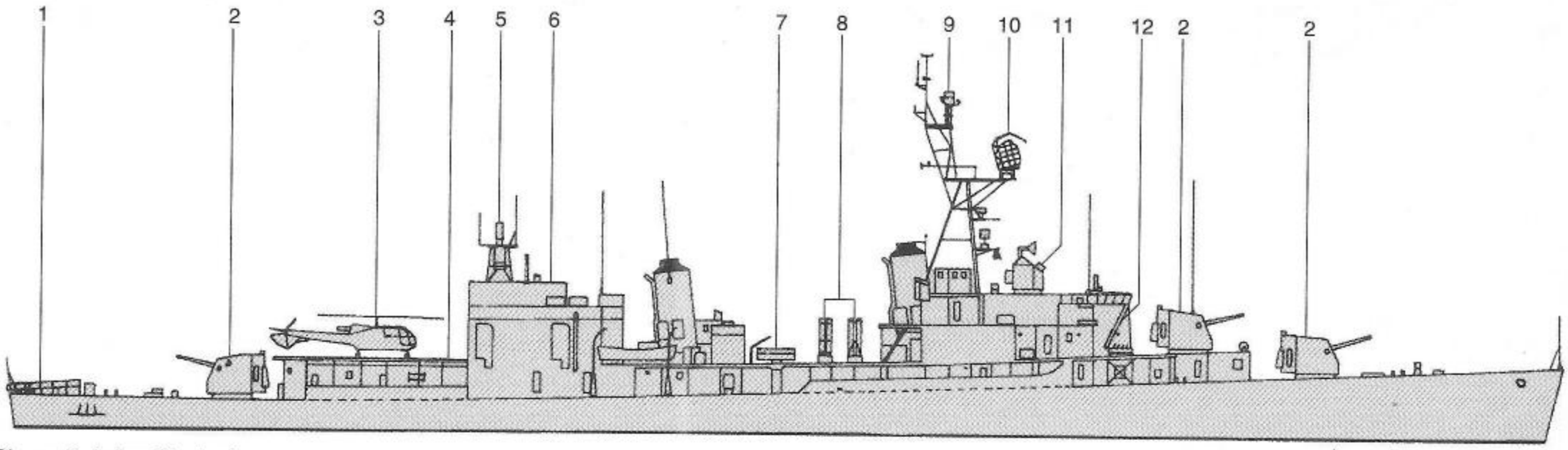
AN/SQS-4, hull-mounted.

PROPULSION

Specifications
System: Steam
Main machinery: 4 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F)
Turbines: 2 General Electric turbines; 45 MW (60,000 hp)
Shafts: 2

Power *(DD 839) enters Malta in 1951. This shows the 'Gearing' class in its original state, before the FRAM conversions started* (H & L van Ginderen Collection)

CHUNG BUK (GEARING)



Chung Buk (Ian Sturton)
1 *Depth charge rack* **2** *Twin 127 mm (5 in)/38 Mk 38 mounting (three mountings in DD 915-916; two in remainder)* **3** *SA 316B Alouette III helicopter (not in DD 925)* **4** *Flight deck* **5** *ULP-6 ESM/ECM* **6** *Hangar* **7** *324 mm Mk 32 triple torpedo launcher* **8** *Harpoon SSM launcher (eight total)* **9** *SPS-10 radar (surface search)* **10** *SPS-40 (air search)* **11** *Mk 25 fire control director* **12** *Hedgehog Mk 11 ASW mortar*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Korea, South
Type: Gearing

Class: CHUNG BUK (FRAM I and II)

Purchased: 7
Active: 7

Displacement:
standard: 2,425 t
full load: 3,470 t

Dimensions
Length: 119 m (390.5 ft)
Beam: 12.6 m (41.2 ft)
Draught: 5.8 m (19 ft)

Speed: 32.5 kts
Range: 3,275 n miles at 11 kts; 975 n miles at 32 kts

Complement: 280

SHIPS

CHUNG BUK (DD 915)

Builder	Bath Iron Works Corporation, Bath, Maine, USA
Laid down	12 Jun 1944
Launched	29 Oct 1944
Commissioned (US Navy)	9 Jan 1945 (*Chevalier* (DD 805))
On loan to ROKN	5 Jul 1972
Sold to ROKN	31 Jan 1977

JEON BUK (DD 916)

Builder	Bath Iron Works Corporation, Bath, Maine, USA
Laid down	4 Sep 1944
Launched	28 Jan 1945
Commissioned (US Navy)	6 Apr 1945 (*Everett F Larson* (DD 830))
On loan to ROKN	30 Oct 1972
Sold to ROKN	31 Jan 1977

TAEJON (DD 919)

Builder	Consolidated Steel Corporation, Orange, Texas, USA
Laid down	14 Apr 1945
Launched	18 Aug 1945
Commissioned (US Navy)	5 Apr 1946 (*New* DD 818))
Sold to ROKN	23 Feb 1977

Jeon Ju *(DD 925) the former US Navy destroyer* Rogers *(DD 876). This ship has a twin 127 mm (5 in) in 'A' and 'Y' positions and a twin Bofors 40 mm in 'B' position, here covered in a tarpaulin. Amidships (just visible) is an ASROC eight-cell launcher and there are two Daewoo ADS gatlings on the former flight deck, aft. On the mainmast (aft) are the two receive antennas of the ULQ-6 system (large cylindrical domes on upper yardarm) while on the lower yardarm is the jammer*
(H & L van Ginderen Collection)

KWANG JU (DD 921)
Builder Bath Iron Works Corporation, Bath, Maine
Laid down 31 Jul 1945
Launched 2 Mar 1946
Commissioned (US Navy) 23 May 1946 (*Richard E Kraus* (DD 849))
Sold to ROKN 23 Feb 1977

KANG WON (DD 922)
Builder Federal SB and DD Co, Newark, USA
Laid down 19 Oct 1944
Launched 8 Jul 1945
Commissioned (US Navy) 21 Sep 1945 (*William R Rush* (DD 714))
Sold to ROKN 1 Jul 1978

KYONG KI (DD 923)
Builder Consolidated Steel Corporation, Orange, Texas, USA
Laid down 10 Oct 1944
Launched 17 Mar 1945
Commissioned (US Navy) 26 Jul 1945 (*Newman K Perry* (DD 883))
Sold to ROKN Feb 1981

JEON JU (DD 925)
Builder Consolidated Steel Corporation, Orange, Texas, USA
Laid down 3 Jun 1944
Launched 20 Nov 1944
Commissioned (US Navy) 26 Mar 1945 (*Rogers* (DD 876))
Sold to ROKN Mar 1981

WEAPONS SYSTEMS

Summary
There are numerous differences between the ships, as summarised below:

Ship		DD-915	DD-916	DD-919	DD-921	DD-922	DD-923	DD-925
Former type		**FRAM I**	**FRAM I**	**FRAM II**	**FRAM II**	**FRAM II**	**FRAM II**	**FRAM II**
Missiles	Harpoon	8	8	8	8	8	–	–
	ASROC	–	–	–	–	–	1	1
Guns	Twin 127 mm	3	3	2	2	2	2	2
	Twin Bofors 40 mm	–	–	2	2	2	2	2
	20 mm Vulcan Gatling	2	2	2	2	2	–	2
ASW systems	Triple 324 mm TT*	2	2	2	2	2	2	2
	Hedgehog	2	2	–	–	–	–	–
	Depth charge rack	1	1	1	1	1	1	1
	Helicopter	1	1	1	1	1	1	–

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas UGM-84B Harpoon

Eight Harpoon anti-ship missile canisters are mounted in two quadruple launchers in DD 915, 916, 919 and 921. They are located between the stacks, with four pointing to either beam. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 kg)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

There is a single Mk 112 ASROC launcher, located between the stacks, in DD 923 and DD 925 only. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 460 m.

When a submarine target is detected, it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m, although the aerodynamically stable airframe enables it to coast up to 600 m. On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and, as they separate, the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications
ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Wing span: 84.5 cm (33.27 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.7 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor
Honeywell Training and Control Systems, West Covina, California.

TUBES

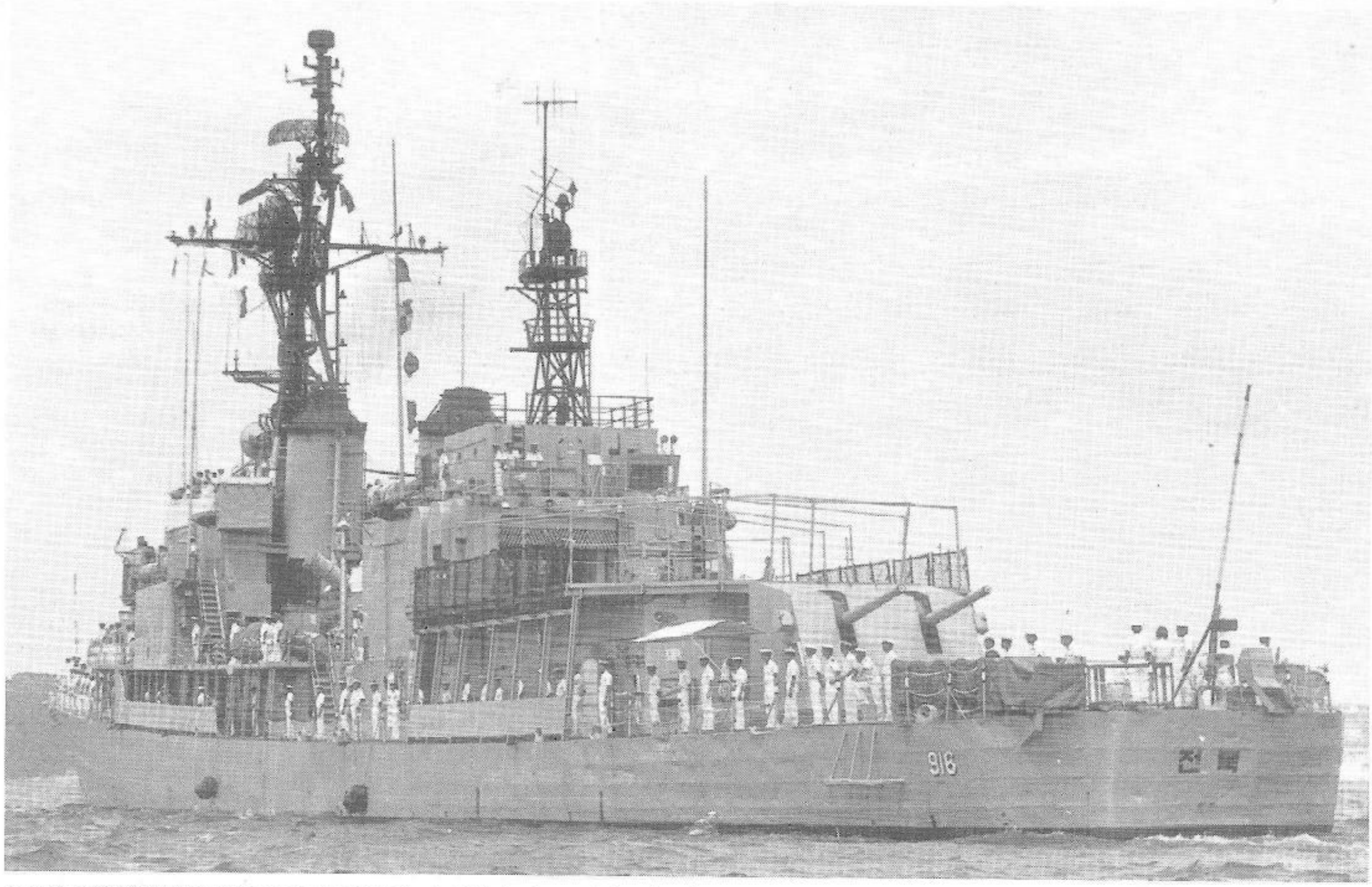
Two triple 324 mm US Mk 32 torpedo tubes are sited amidships on all ships.

Specifications
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

AlliantTechsystems Mk 46 324 mm torpedoes

Specifications
Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 232 kg (511.5 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: mono-propellant
Speed: 45 kts
Range: 4.5 n miles (8.33 km)
Acquisition range: 460 m (1,510 ft) (estimated)



Jeon Buk *(DD 916). This ship retains the flight deck which has been widened and strengthened. Amidships are eight Harpoon SSM launchers. Note that the configuration of the mainmast on the hangar roof is different from other ships in the class. There are no yardarms and the mast is topped by two highly directional Yagi antennas, and several UHF and possibly I-band receive antennas, suggesting a possible ELINT capability* (H & L van Ginderen Collection)

GUNS

Mk 30/38 127 mm (5 in) L/38 gun mounting

The two FRAM II ships (DD 915, 916) have three Mk 38 mountings, two forward, one aft, while the others have two mountings, one forward and one aft. The Mk 38 mountings use two Mk 12 guns, with shells being loaded manually into a hydraulically powered ramming tray. The mount is worked in manual, local or remote control. With automatic control it is operated by a remote fire-control system by means of indicator regulators on the single training gear assembly and the single elevating assembly. Each gun has its own projectile and propellant hoists, with the projectile hoist lift pawls also acting as fuze setters. The mounting requires 13 men within the armoured shield and 14 in the magazines. The approximate life of each barrel is 4,600 EFC (Equivalent Full Charges).

Specifications

Calibre: 127 mm
Length of barrel: 38 calibres
Muzzle velocity: 792 m/s (new gun), 762 m/s (mid-life) (2,600/2,500 ft/s)
Range: 13.5 n miles (25.26 km)
Altitude: 12,836 m (40,600 ft)
Weight of shell: 24.95 kg
Traverse: ±164° at 25°/s
Elevation: −15 to +85° at 15°/s
Rate of fire: 36 rds/min

40 mm BOFORS L/60 in US Mk 1 mounting

All except DD 915 and DD 916 have two twin Bofors 40 mm guns in US Navy Mk 1 mountings, with two air-cooled guns, firing HE-T and HEI-T rounds. The two guns are 243 mm (9.56 in) apart on the mounting and are slaved in elevation.

Specifications

Gun
Calibre: 40 mm
Length of barrel: 56.25 calibres
Muzzle velocity: 881 m/s (new gun); 850 m/s (mid-life) (2,890/2,788 ft/s)
Range: 5.5 n miles (10 km) surface/surface, 6,900 m AA nominal (US)
Rate of fire: 80 rds/min (practical), 160 rds/min (cyclic) for water-cooled weapons
Ammunition: 2.21 kg
Barrel life: 9,500 EFC (approx)

Mounting (US Mk 1)
Weight: 4.45-6.76 t
Traverse: 360° at 30°/s
Elevation: −15 to +85/90° at 24°/s
Crew: 4

20 mm Daewoo SEA VULCAN 20/20P/JM 61MB (Daewoo 20 mm ADS)

Some have Daewoo ADS, a fully enclosed and possibly environmentally controlled mounting for one six-barrelled M-168 gun. Each barrel has a life of 36,000 rounds and the gun may be fired in 10, 30, 60 or 100-round bursts. The below-deck magazine appears to contain 750 rounds of ammunition. The mounting is believed to be electrically controlled and uses the GSA Mk 3 gyroscopic lead-computing gunsight and, probably, a range update computer although it is linked with the ship's weapon control system. The gunner identifies the target visually, estimates the speed and range (although these may be provided by the ship's weapon control system). The gunner enters these settings, traverses the mounting then uses the on-sight gunsight to acquire the target. The computer then automatically provides the lead angles and elevation.

Specifications

(Daewoo ADS)
Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s
Rate of fire: 1,000-3,000 rds/min
Weight of shell: 294 g
Effective range:
anti-surface: 1 n mile (1.85 km)
anti-air: 1,200 m

Mounting
Traverse: 360°
Elevation: −5 to +80°
Traverse speed: 70°/s
Elevation speed: 40°/s
Weight (unloaded): 1,200 kg

Manufacturer/Contractor

Daewoo Heavy Industries Ltd.

ANTI-SUBMARINE MORTARS

Projector Mk 11 (Hedgehog)

Despite its age, the Hedgehog anti-submarine spigot mortar is retained, with two forward-firing mountings either side of the bridge in *Chang Buk* (DD 915) and *Jeon Buk* (DD 916) only. The US Navy Mk 11 mountings each hold 24 rounds in four vertical rows each of six, with an electric motor giving the spigots a traverse of 25° as well as compensating for roll. The Mk 11 mounting fires the bombs into a circular pattern with a 41 m radius at a range of 230-250 m.

Specifications

Projectile
Diameter: 177.8 mm (7 in)
Weight: 29.5 kg (65 lb)
Fuze: impact
Explosive weight: 13.6 kg (30 lb)
Sinking speed: 7.6 m/s (25 ft/s)

DEPTH CHARGES

These ships retain a single Mk IX depth charge rack, for which 12 depth charges are carried.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

WLR-1
WLR-1 is a US-manufactured, manually operated, radar warning system covering frequencies from 50 MHz to 10.75 GHz, employing a number of separate antennas.

WJ-1140
The WJ-1140 is a commercially produced signal acquisition system by the US company Watkins-Johnson, and is installed aboard the destroyer *Jeon Buk* (DD 916) only. It is probably used for ELINT purposes.

ULQ-6
ULQ-6 is a deception jammer which was originally developed to deal with the threat posed by Soviet missiles such as SS-N-2. At least one ship has the received elements of ULQ-6 but not the jammer.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Mk 37 GFCS
The Mk 37 Gun Fire Control System (GFCS) is used for the 127 mm guns and is a Second World War vintage system, now only to be seen on elderly ex-US Navy destroyers, such as this. The director incorporates a 4.6 m (15 ft) stereoscopic rangefinder and a Mk 25 H/I-band radar.

Mk 51 GFCS
There is one Mk 51 Mod 2 Gun Fire Control System (GFCS), for the Bofors 40 mm mountings in all ships except DD 915 and DD 916. It includes a Mk 26, E/F-band, range-only radar. Maximum tracking range is 25,000 m.

IFF
UPX 1-12 in DD 919 and DD 921 only.

SONARS

SQS 29
SQS-29 is installed in DD 915 and DD 916 only. It is a hull-mounted, active search and attack sonar, operating at high frequency, and was based on the SQS-4 Mod 1, but with a passive search capability.

Specifications
Frequency: 8 kHz
Pulse length: 2, 7, 30, or 120 ms
Nominal range: 6,900 m (7,500 yd)

RADARS

Set	SPS-40 (Not DD-921)	SPS-37 (DD-921 only)	SPS-10	Mk 25 (Mk 37 GFCS)
Company	Lockheed	Westinghouse	Raytheon/Sylvania	Western Electric
Role	Air search	Air search	Surface search	Fire Control
Band	E/F	A/B	G	I/J
Range	175 n miles (320 km)	—	—	91,000 m (100,000 yd)
Beam	1.5 × 16°	19 × 25.5°	1.5 × 16°	1.6°
Peak power	500 kW	750 kW	500 kW	250 kW
Gain	30 dB	18 db	30 dB	39 dB
Pulsewidth	0.25/1.3 µs	10 µs	0.25/1.3 µs	0.25 µs
PRF	650 pps	300 pps	650 pps	1,320 pps
Scan rate	15 rpm	7.5/15 rpm	15 rpm	—

Sangamo SQS 23
SQS-23 is installed in all ships except DD 915 and DD 916. Like SQS-29, it is a hull-mounted, active search and attack sonar, but operated at low frequency, and is the sonar designed to operate with the ASROC system. The array is cylindrical and has 48 staves, each with two transducers.

Specifications
Frequency: 4.5/5/5.5 kHz
Pulse length: 5/30/50 ms
Nominal range: 14,000 m (15,000 yd)

AVIATION

AVIATION FACILITIES

Flight deck
All have a flight deck and a hangar, but these facilities cannot be used in *Jeon Ju* (DD 925). One helicopter is operated, previously an Aerospatiale SA 316B Alouette III, but now a Westland Super Lynx.

Westland Super Lynx

Specifications
Dimensions
Main rotor diameter: 12.80 m (42.0 ft)
Tail rotor diameter: 2.36 m (7.75 ft)
Length overall, rotors turning: 15.24 m (50.0 ft)
Width overall, main rotor blades folded: 2.94 m (9.65 ft)
Height overall, rotors turning: 3.67 m (12.0 ft)
Weights:
basic, empty: 3,291 kg (7,255 lb)
operating, empty: ASW (2 torpedoes) 4,618 kg (10,181 lb); ASV (four Sea Skuas) 4,373 kg (9,641 lb)
surveillance and targeting: 3,708 kg (8,174 lb)
search and rescue: 3,778 kg (8,329 lb)
max take-off: 5,125 kg (11,300 lb)
Never-exceed speed (VNE), clean: 156 kts (289 km/h)
IR exhaust diffusers fitted: 145 kts (269 km/h)
Power plant: 2 Rolls-Royce Gem 42-1 turboshafts, each rated at 835 kW (1,120 shp)
Transmission rating: 1,372 kW (1,840 shp)
Armament: ASW armament includes 2 Mk 44, Mk 46, A244S or Sting-Ray homing torpedoes, one each on an external pylon on each side of fuselage, and 6 marine markers; or 2 Mk 11 depth charges. Alternatively, up to 4 Sea Skua or 2 Penguin anti-ship missiles

PROPULSION

Specifications
System: Steam turbines
Main machinery: 4 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 General Electric turbines; 45 MW (60,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

The first two ships, *Chung Buk* and *Jeon Buk,* had originally been standard 'Gearing' class destroyers, but were among those converted to radar pickets in 1949. They were modernised under the FRAM II programme in the 1960s and transferred on loan to the ROKN in 1972, being purchased outright in 1977.

Of the remaining five ships, three were completed as standard Gearings, while *Newman K Perry* (DD 883) and *Rogers* (DD 876) were built as radar pickets (DDR), joining the Pacific Fleet in 1945. *William R Rush* was converted to a DDR in 1953, but in the 1960s all were modernised under the FRAM I programme.

MODERNISATION

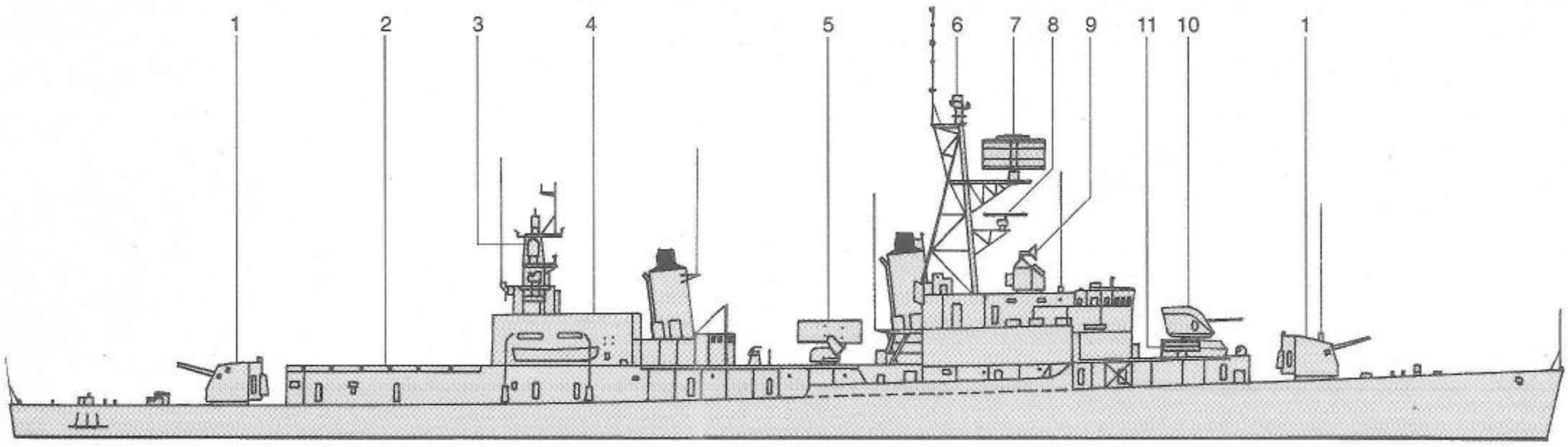
All ships have been refitted in Taiwanese shipyards, although there are numerous differences between them. The major difference is that five have been armed with eight Harpoon launchers (fitted in 1979), which are located in the space between the stacks, with four tubes pointing to either beam. The other two (DD 923 and DD 925) are armed, instead, with ASROC, with a Mk 112 octuple launcher similarly located between the stacks.

All have had a large hangar added immediately abaft the after stack, which is offset to port, but there appear to be a number of differences in the design. The flight deck is relatively large, but in *Jeon Ju* (DD 925) two GE Vulcan Gatling Close in Weapons Systems (CIWS) have been sited at its after end, making the flight deck unusable for helicopters. In DD 915 and DD 919 the helicopter deck has been strengthened.

Most ships have TACAN and Satcom terminals fitted. There is some visual evidence that the RoKN has modified or replaced much of the electronic equipment aboard these ships.

Chung Buk *(DD 915). This ship has three twin 127 mm (5 in) mounts, eight Harpoon missile launchers and the strengthened helicopter deck. The mainmast is different again, with the receive elements of ULQ-6 but not the jammers* (H & L van Ginderen Collection)

ILHUICAMINA (GEARING)



Netzahualcoyotl (Ian Sturton)
1 *127 mm (5 in)/38 Mk 38 twin mount* **2** *Flight deck* **3** *ULQ-6 jammer* **4** *Hangar* **5** *Mk 112 ASROC octuple launcher* **6** *SPS-10 radar (surface search)* **7** *SPS-29 radar (air search)* **8** *LN-66 radar (navigation)* **9** *Mk 12/22 GFCS* **10** *Bofors 57 mm/70 Mk 2* **11** *Mk 32 324 mm triple torpedo tubes*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Mexico
Type: Gearing

Class: ILHUICAMINA

Purchased: 2
Active: 2

Displacement:
standard: 2,425 t
full load: 3,690 t

Dimensions
Length: 118.7 m (390.2 ft)
Beam: 12.5 m (41.9 ft)
Draught: 4.6 m (15 ft)

Speed: 32.5 kts (see 'Further Information' below)
Range: 5,800 n miles at 15 kts

Complement: 300

SHIPS

ILHUICAMINA (E 10)

Builder	Bethlehem Steel, Staten Island, New York, USA
Laid down	3 Aug 1944
Launched	15 Jan 1945
Commissioned (US Navy)	28 Apr 1945 (*Vogelgesang* (DD 862))
Sold to Mexico	24 Feb 1982

NETZAHUALCOYOTL (E 11)

Builder	Bethlehem Steel, Staten Island, New York, USA
Laid down	1 Sep 1944
Launched	13 Feb 1945
Commissioned (US Navy)	26 May 1945 (*Steinaker* (DD 863))
Sold to Mexico	24 Feb 1982

WEAPONS SYSTEMS

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

There is a single Mk 112 ASROC launcher, although it is believed that the Mexican Navy gives ASW a very low priority. The launcher is located between the stacks. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo which has a seeker designed specifically to detect most types of target, including submarines with anechoically coated hulls, and has an estimated acquisition range of 460 m (1,510 ft).

When a submarine target is detected, it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (200-1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (1,970 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and, as they separate, the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications

ASROC missile
Length: 4.6 m
Diameter: 32.5 cm
Wing span: 84.5 cm
Weight: 435 kg
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm
Length: 2.95 m
Weight: 230 kg
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg; PBXN-103

Manufacturer/Contractor

Honeywell Training and Control Systems, West Covina, California.

TUBES

Two triple 324 mm US Mk 32 torpedo tubes are sited amidships in both ships.

Specifications

Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

Manufacturer/Contractor

GEC-Marconi Naval Systems, UK.

TORPEDOES

AlliantTechsystems Mk 46 324 mm torpedoes

Specifications

Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 232 kg (511.5 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: mono-propellant
Speed: 45 kts
Range: 4.5 n miles (8.33 km)
Acquisition range: 460 m (1,510 ft) (estimated)

GUNS

Mk 30/38 5 in L/38 gun mounting

These two ships have two Mk 38 mountings, one

forward and one aft. The Mk 38 mountings use two Mk 12 guns, with shells being loaded manually into a hydraulically powered ramming tray and are worked in manual, local or remote control. With automatic control it is operated by a remote fire-control system by means of indicator regulators on the single training gear assembly and the single elevating assembly. Each gun has its own projectile and propellant hoists, with the projectile hoist lift pawls also acting as fuze setters. The mounting requires 13 men within the armoured shield and 14 in the magazines. The approximate life of each barrel is 4,600 EFC (Equivalent Full Charges).

Specifications
Calibre: 127 mm
Length of barrel: 38 calibres
Muzzle velocity: 792 m/s (new gun), 762 m/s (mid-life)
Range: 13.5 n miles (25.26 km)
Altitude: 12,836 m (42,000 ft)
Weight of shell: 24.95 kg (55 lb)
Traverse: ±164°
Elevation: −15 to +85°
Traverse rate: 25°/s
Elevation rate: 15°/s
Rate of fire: 36 rds/min

Bofors SAK 57 L/70 Mk 2
One 127 mm twin turret has been removed and replaced by a single SAK 57. The SAK 57 Mk 2 uses a Bofors L/70 gun in a plastic turret, which has been designed to minimise its radar cross-section, while aluminium is used in the elevating mass wherever practical to reduce the mounting's magnetic signature further. The turret is unmanned, being controlled from a panel in the combat information centre, and is stabilised using rate gyros to detect ship movement and to provide stabilisation orders. There are two microprocessor-based computers; one controlling the loading system and the mounting, while the other is used for aiming and firing limitation.

The hydraulically operated loading system is automatic, with clips of ammunition coming up the hoist into the round receiver, where a loading arm pushes them into a cassette, which is subdivided into two racks, each with a capacity of 10 rounds. The cassettes, one for each side of the magazine, move sideways along a horizontal rod mounted above the floor at the rear of the upper mounting. The loading sequence begins with the gun being laid to a special position and the cassette is moved to a position above the round receiver. Each rack of the cassette is loaded and then it is moved inboard to a position above the magazine where it loads both racks simultaneously. The cassette returns to the round receiver for refilling and then moves outboard and fills the intermediate magazine. Once again it returns to the round receiver where it is again reloaded. When the loading procedure is complete there are 120 rounds in the turret. To reload the magazine it must be elevated to 77° so that the cassette may come into position. While the gun is firing the cassette itself is refilled from the intermediate magazine.

Two types of fixed 6.1 kg ammunition are available: one is a proximity-fuzed prefragmented shell for use against aerial targets; the other is a special surface target shell which penetrates the target and is detonated after a short delay. The mounting can be equipped with rocket-launching rails for 57 mm (2 in) rockets. These can be fired by the operator.

Specifications
Calibre: 57 mm
Length of barrel: 70 calibres
Traverse: 360°
Elevation: −10 to +77°
Traverse speed: 55°/s
Elevation speed: 40°/s
Mounting weight: 6.7 t
Crew: 3
Range: 9 n miles (17 km)
Rate of fire: 220 rds/min

Manufacturer/Contractor
CelsiusTech, Sweden.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES/ ELECTRONIC SUPPORT MEASURES (ECM/ESM)

WLR-1
WLR-1 is a US-manufactured, manually operated, radar warning system covering frequencies from 50 MHz to 10.75 GHz, employing a number of separate antennas.

ULQ-6
ULQ-6 is a deception jammer.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Mk 37 GFCS
The Mk 37 Gun Fire Control System (GFCS) is used for the 127 mm guns and is a Second World War vintage system, now only to be seen on elderly ex-US Navy destroyers, such as this. The director incorporates a 4.6 m (15 ft) stereoscopic rangefinder and a Mk 25 H/I-band radar.

SONARS

Sangamo SQS-23
SQS-23 is installed in both ships. It is a hull-mounted, active search and attack sonar, but operated at low frequency, and is the sonar designed to operate with the ASROC system. The array is cylindrical and has 48 staves, each with two transducers.

Specifications
Frequency: 4.5/5/5.5 kHz
Pulse length: 5/30/50 ms
Nominal range: 14,000 m (15,000 yd)

RADARS

Set	SPS-40 (E-03 only)	SPS-29 (E-04 only)	SPS-10	LN-66	Mk 25 (Mk 37 GFCS)
Company	Lockheed	Westinghouse	Raytheon/Sylvania	Canadian Marconi	Western Electric
Role	Air search	Air search	Surface search	Navigation	Fire Control
Band	E/F	A/B	G	I/J	I/J
Range	175 n miles (320 km)	250 n miles (457 km)	—	—	91,000 m
Beam	1.5 × 16°	19 × 25.5°	1.5 × 16°	2.5 × 22°	1.6°
Peak power	500 kW	750 kW	500 kW	75 kW	250 kW
Gain	30 dB	18 dB	30 dB	—	39 dB
Pulsewidth	0.25/1.3 µs	10 µs	0.25/1.3 µs	1.0/0.1 µs	0.25 µs
PRF	650 pps	300 pps	650 pps	500/2,000 pps	1,320 pps
Scan rate	15 rpm	7.5/15 rpm	15 rpm	22 rpm	—

AVIATION

AVIATION FACILITIES

Flight deck
A large flight deck has been fitted, together with a hangar replacing the after, super-firing twin 127 mm mounting.

HELICOPTERS

Eurocopter MBB Bö-105CB

Both ships can embark one Bö-105 helicopter, which can be armed with machine-guns or rocket pods, if necessary.

Specifications

Dimensions
Main rotor diameter: 9.84 m (32.28 ft)
Tail rotor diameter: 1.90 m (6.23 ft)
Length (including main and tail rotors): 11 m (38.91 ft)
Height to top of main rotor head: 3.02 m (9.91 ft)
Weights
basic, empty: 1,301 kg (2,868 lb)
max take-off: 2,500 kg (5,511 lb)
Performance (at max T-O weight)
never-exceed speed (VNE) at sea level: 131 kts (242 km/h)
max cruising speed at sea level: 129 kts (240 km/h)
best range speed at sea level: 110 kts (204 km/h)
max rate of climb at sea level, max continuous power: 444 m (1,457 ft)/min
Max operating altitude (2,500 kg (5,511 lb)): 3,050 m (10,000 ft)
Range with standard fuel and max payload, no reserves:
at sea level: 300 n miles (555 km)
at 1,525 m (5,000 ft): 321 n miles (596 km)
Ferry range with auxiliary tanks, no reserves:
at sea level: 519 n miles (961 km)
at 1,525 m (5,000 ft): 550 n miles (1,020 km)
Endurance with standard fuel and max payload, no reserves:
at sea level: 3 h 24 min
Power plant: 2–313 kW (420 shp) Allison 250-C20B turboshafts, each with a max continuous rating of 298 kW (400 shp)
Accommodation: 5 (pilot and co-pilot/passenger in front seats. Bench seat at rear for 3 persons)
Avionics: Wide variety of avionics available including weather radar, Doppler and GPS navigation, 360° search radar, FLIR, TV broadcast and microwave datalink

PROPULSION

Specifications

System: Steam turbines
Main machinery: 4 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 General Electric steam turbines; 45 MW (60,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

These ships, both FRAM I conversions, were transferred to the Mexican Navy by purchase on 24 February 1982.

MODERNISATION

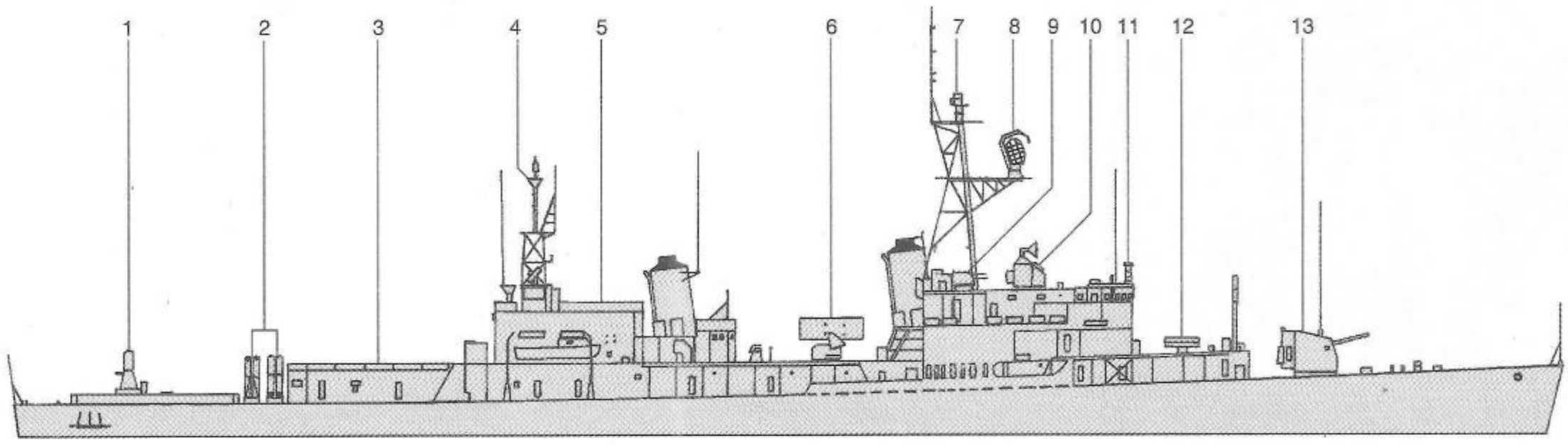
During their time in the Mexican Navy these ships have undergone several modifications, of which the most major is the fitting of a hangar and flight deck, which accommodate an MBB Bö-105 CB helicopter, which resulted in the removal of the after super-firing mounting. The forward super-firing mounting was removed in 1993 and replaced by a single Bofors 57 mm automatic mounting, which has enhanced the ship's firepower, to increase its effectiveness in its anti-smuggling duties.

Another modification is the installation of devices on top of the stacks to reduce the ships' IR signatures.

It is reported that these ships are no longer capable of the top speed of 32 knots.

Netzahualcoyotl *(E–04). Note the Bofors 57 mm gun in 'B' position*

ALAMGIR (GEARING)



Tughril (Ian Sturton)
1 *Mk 15 Vulcan Phalanx 20 mm CIWS* **2** *Harpoon anti-ship missile launchers (eight)* **3** *Flight deck* **4** *APECS II ESM/ECM system* **5** *Hangar* **6** *Mk 112 ASROC octuple launcher* **7** *SPS-10 radar (surface search)* **8** *SPS-40 (air search)* **9** *Quad 23 mm cannon mounting* **10** *Mk 25 GFCS director* **11** *Racal Decca TM 1226 radar (navigation)* **12** *Mk 32 324 mm torpedo launcher (triple)* **13** *127 mm (5 in) Mk 38 twin mount*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Pakistan
Type: Gearing (FRAM I)

Class: ALAMGIR

Purchased: 6
Active: 3

Displacement:
standard: 2,425 t
full load: 3,500 t

Dimensions
Length: 119 m (390.5 ft)
Beam: 12.6 m (41.2 ft)
Draught: 5.8 m (19 ft)

Speed: 32 kts
Range: 4,500 n miles at 16 kts

Complement: 274 (27 officers)

SHIPS

ALAMGIR (D 160)

Builder	Bethlehem Steel, Staten Island, New York, USA
Laid down	30 Nov 1944
Launched	10 May 1945
Commissioned (US Navy)	18 Aug 1945 (*Cone* (DD 866))
Transferred	1 Oct 1982

TAIMUR (D 166)

Builder	Todd Pacific Shipyards, Seattle, Washington, USA
Laid down	20 Jun 1945
Launched	29 Dec 1945
Commissioned (US Navy)	19 Mar 1949 (*Epperson* (DD 719))
Transferred	30 Sep 1980

TUGHRIL (D 167)

Builder	Todd Pacific Shipyards, Seattle, Washington, USA
Laid down	27 Oct 1944
Launched	28 May 1945
Commissioned (US Navy)	4 Aug 1945 (*Henderson* (DD 785))
Transferred	30 Sep 1980

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas RGM-84B Harpoon

Six Harpoon anti-ship missile canisters are mounted in three pairs on the after deck. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion pattern and, for the terminal phase, have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

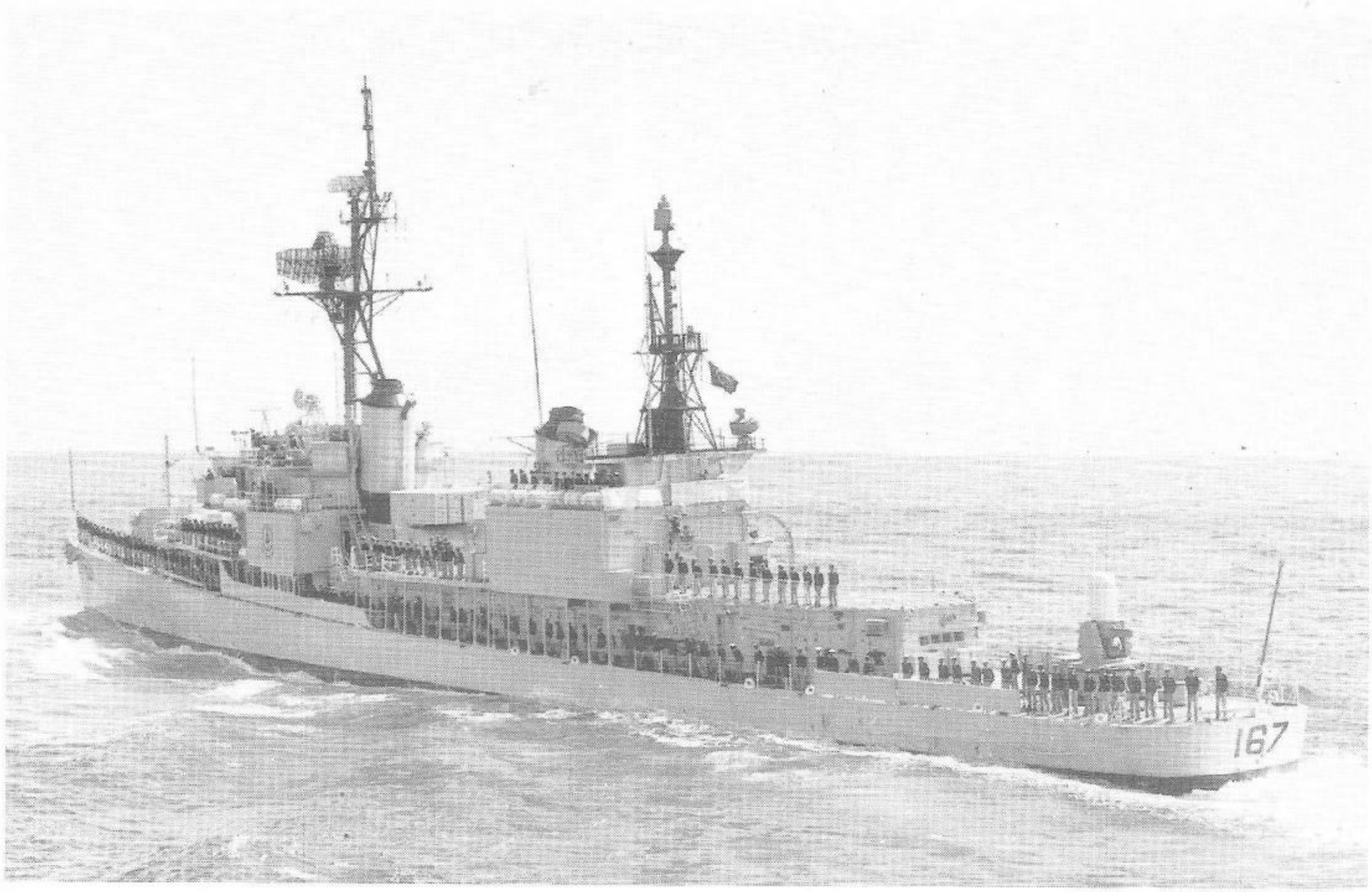
ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

There is a single Mk 112 ASROC launcher, located between the stacks, with eight reloads. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target, including submarines with anechoically coated hulls, and has an estimated acquisition range of 460 m (1,509 ft).

When a submarine target is detected, it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (200-1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (2,000 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and, as they separate, the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications
ASROC missile
Length: 4.6 m (15.1 ft)



Tughril *(D 167). Armament comprises a twin 127 mm (5 in) mount in 'A' position, two triple 324 mm torpedo tubes forward of the bridge, an eight-round ASROC launcher amidships and a Mk 15 Phalanx CIWS at the stern. It also usually carries six Harpoon missiles forward of the Phalanx but they are not installed in this picture* (H & L van Ginderen Collection)

Diameter: 32.5 cm
Wing span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.7 in)
Length: 2.95 m (9.68 in)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor
Honeywell Training and Control Systems, West Covina, California.

TUBES

Two triple 324 mm US Mk 32 torpedo tubes are sited forward in the 'B' gun position.

Specifications
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

Alliant Techsystems Mk 46 Mod 5 324 mm (12.75 in) torpedoes

Specifications
Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507.0 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

GUNS

Mk 38 127 mm (5 in) L/38 gun mounting
There is one Mk 38 twin mounting in 'A' position with two Mk 12 guns. Shells are loaded manually into a hydraulically powered ramming tray and the mount is worked in manual, local or remote control. With automatic control it is operated by a remote fire-control system by means of indicator regulators on the single training gear assembly and the single elevating assembly. Each gun has its own projectile and propellant hoists, with the projectile hoist lift pawls also acting as fuze setters. The mounting requires 13 men within the armoured shield and 14 in the magazines. The approximate life of each barrel is 4,600 EFC (Equivalent Full Charges).

Specifications
Calibre: 127 mm
Length of barrel: 38 calibres
Muzzle velocity: 792 m/s (new gun), 762 m/s (mid-life) (2,598/2,500 ft/s)
Range: 13.5 n miles (25.26 km)
Altitude: 12,836 m
Weight of shell: 24.95 kg
Traverse: ±164° at 25°/s
Elevation: −15 to +85° at 15°/s
Rate of fire: 36 rds/min

Hughes Mk 15 CIWS Phalanx
There is one Hughes Mk 15 Phalanx close in weapons system (CIWS) situated at the stern. The mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n miles (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds. The Australian Navy operates a fleet pool of these mounts, rotating them between the ships.

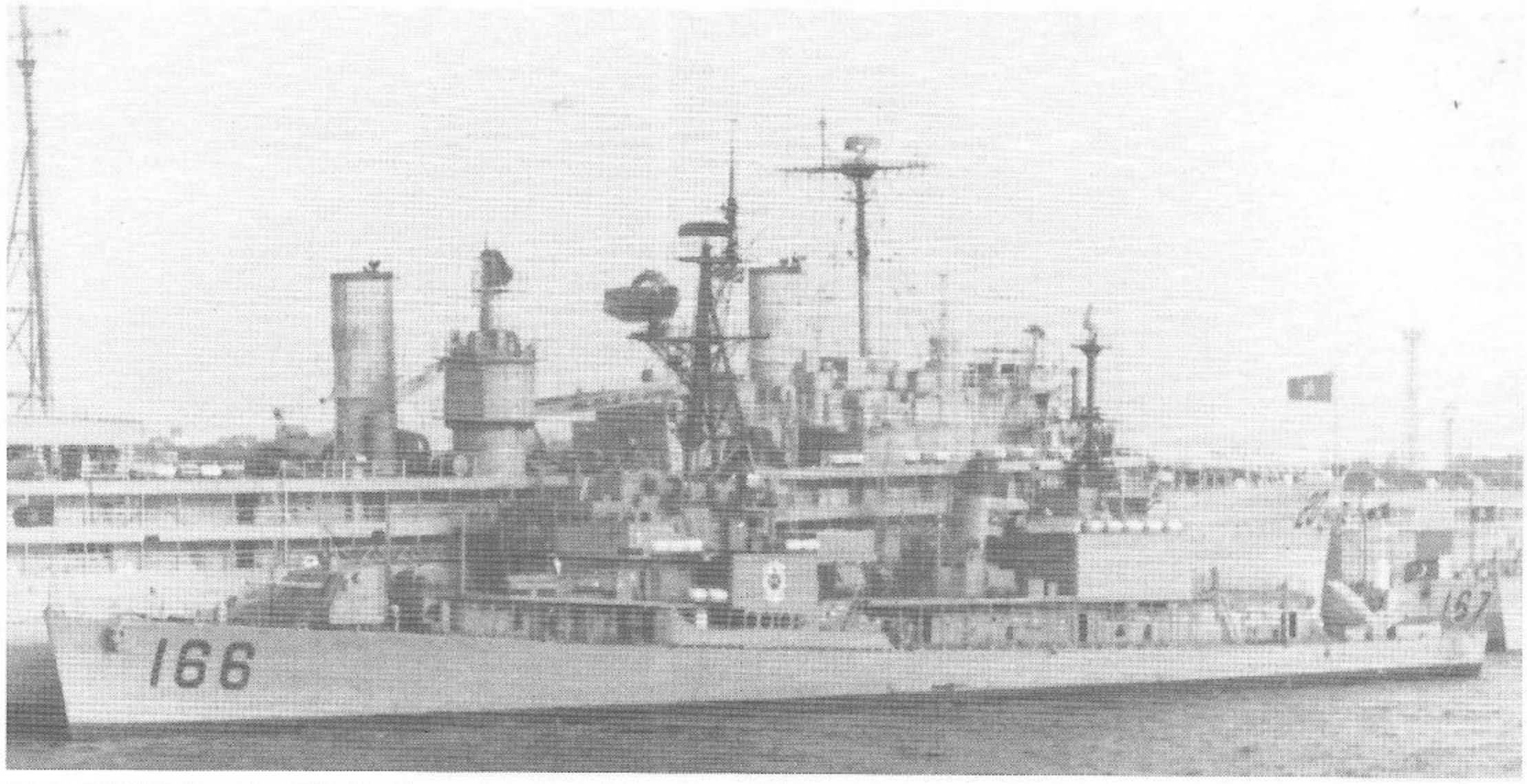
Specifications
Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse-Doppler

Manufacturer/Contractor
Hughes Missile Systems, Tucson, Arizona, USA (system).

23 mm/63 calibre Type 61 twin cannon
These ships do not have the Bofors 40 mm or Oerlikon 20 mm cannon found in other ex-US Navy destroyers, but have, instead, two quad 23 mm mountings situated either side of the forward stack. These are similar to the Russian ZSU-23-4 mounting but are presumably the Type 21 version obtained through the People's Republic of China.

Specifications
(ZSU-23-4)
Calibre: 23 mm
Length of barrel: 870 calibres
Traverse: 360°
Elevation: −10 to +85°
Rates of fire (per barrel): 200 rds/min (practical)
Projectile: 0.19 kg HEI-T
Range:
anti-surface: 1.1 n miles (2.0 km)
anti-air: 1,500 m



Taimur *(D 166) in November 1993. The Harpoon launcher canisters are installed aft, but are covered in tarpaulins* (H & L van Ginderen Collection)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

APECS II radar detection and jamming system

APECS II is an advanced modular ESM/ECM system covering frequencies from 0.5 to 18 GHz, which is designed to counter most known radar threats. It is a fully automatic system, identifying and jamming threat emitters using a mixture of IFM receivers and microprocessor-controlled jammers, with high-speed switching enabling up to 16 threats to be jammed simultaneously. The antenna array consists of a mast-mounted ESM antenna assembly with two DF arrays, one omnidirectional unit and two monopulse units; system processing equipment; operator's console and two ECM transmitters (port and starboard) with their antenna systems located inside the transmitter units.

Specifications

ESM frequency coverage: 0.5-18 GHz
High sensitivity: up to −67 dBm
Detection ranges:
ships: 200 n miles
aircraft: 50 n miles
DF accuracy: 4° RMS; 2° RMS fine DF
Automatic tracking: 500 active signals in dense signal environment
Signal identification speed: <1s
ECM azimuth coverage: 360° using a 60-beam jammer (one beam per 6° azimuth sector)
Radiated power: 180 kW nominal mid-band
ECM frequency coverage: 7.5-18 GHz

Manufacturer/Contractor

ARGOSystems Inc, Sunnyvale, California.

DECOYS

Plessey Shield Tactical Decoy System

There are two launchers, each with six parallel barrels, for the Plessey Shield system, sited on either beam. Shield is a microprocessor-controlled, fully automatic missile decoy system, which is designed to provide effective protection for various sizes of ship, including fast attack craft, corvettes, frigates and destroyers. On detecting a threat, Shield selects the most appropriate response from up to six million scenarios held in its EPROM memory, using data obtained from onboard sensors such as radar and ESM and then automatically deploys the pattern of decoys that will give the highest probability of success. Marconi chaff rockets are fitted with a variable fuze which allows the chaff to be dispersed at optimum positions along the trajectory. To counter threats with a dual-mode capability, both chaff and infra-red decoys can be deployed automatically. Shield offers four protection modes — confusion; distraction; seduction/breaklock; and seduction dump — and uses two types of decoy — chaff and infra-red — which may be used on their own, or in combination with each other.

Manufacturer/Contractor

GEC-Marconi Naval Systems, Addlestone, UK.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Mk 37 GFCS

The Mk 37 Gun Fire Control System (GFCS) is used for the 127 mm guns and is a Second World War vintage system, now only to be seen on elderly ex-US Navy destroyers, such as this. The director incorporates a 4.6 m (15 ft) stereoscopic rangefinder and a Mk 25 H/I-band radar.

SONAR

Sangamo AN/SQS-23D

AN/SQS-23D is a hull-mounted, active search and attack sonar, operating at low frequency, and is the sonar designed to operate with the ASROC system. The array is cylindrical and has 48 staves, each with two transducers.

Specifications

Frequency: 4.5/5/5.5 kHz
Pulse length: 5/30/50 ms
Nominal range: 14,000 m (15,000 yd)

RADARS

Set	SPS-40	SPS-10	TM 1226	Mk 25 (Mk 37 GFCS)
Company	Lockheed	Raytheon/Sylvania	Racal Decca	Western Electric
Role	Air search	Surface search	Navigation	Fire Control
Band	E/F	G	I	I/J
Range	175 n miles (320 km)	—		91,000 m
Beam	1.5 × 16°	1.5 × 16°	1.2°	1.6°
Peak power	500 kW	500 kW	(average) 25 kW	250 kW
Gain	30 dB	30 dB	30 dB	39 dB
Pulsewidth	0.25/1.3 µs	0.25/1.3 µs	0.05/0.25/1.0 µs	0.25 µs
PRF	650 pps	650 pps		1,320 pps
Scan rate	15 rpm	15 rpm	28 rpm	—

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 17 × 11 m (56 ft × 35 ft)
Hangar: There is a twin hangar

HELICOPTERS

The aircraft intended for operations with these ships are the eight SA 319B Alouette IIIs, but they are rarely deployed.

PROPULSION

Specifications
System: Steam turbines
Main machinery: 4 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 General Electric turbines; 45 MW (60,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

Pakistan has acquired six former 'Gearing' class destroyers from the USA: *Tariq* (D 165) and *Taimur* (D 166) in 1977; *Tughril* (D 167) and *Tippu Sultan* (D 168) in 1980; *Alamgir* (D 160) in 1982 and *Shah Jahan* (D 164) in 1983. Two have been transferred to the Maritime Safety Agency (MSA), the main role of which is to patrol the 200 n miles EEZ. A third ship, *Shah Jehan* (D170) was stripped of usable spares and then sunk as a target in missile firing tests. Three ships remain in navy service.

MODERNISATION

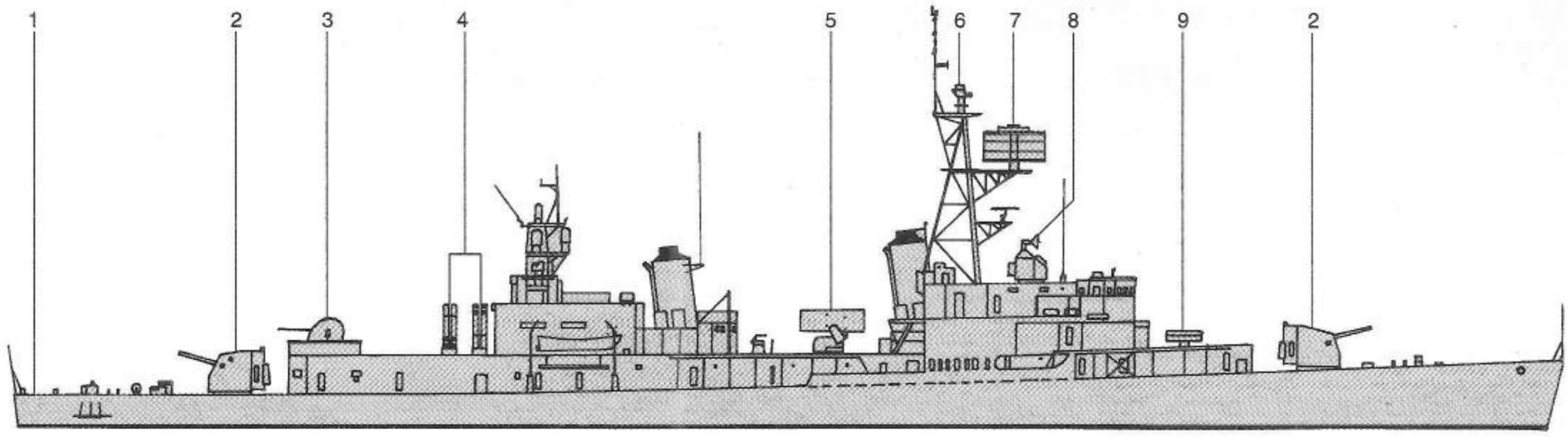
The ships were refitted in the United States prior to delivery to Pakistan and have since been further modernised. The modernisation work has included fitting Harpoon SSMs and Vulcan Phalanx on the after deck in place of Y gun turret, installing improved EW equipment and the addition of two Chinese 23 mm quadruple mountings at the base of the foremast.

OPERATIONAL

These ships form 25th Destroyer Squadron.

Tughril *(D 167). Antennas on the foremast are SPS-10 surface search (top) and SPS-40 (air search), with the Mk 25 GFCS director on the bridge roof. Also on the bridge roof and to the left of the Mk 25 GFCS is the TM 1226 navigation radar antenna on top of a small tripod. Communications systems include OE-2 satellite antennas (at the after corners of the hangar roof), a surprising number of vertical rod antennas and the APECS-II ESM/ECM array atop the mainmast. Also visible are the two quad 23 mm mounts either side of the mainmast* (H & L van Ginderen Collection)

YUCETEPE, TURKEY



Yucetepe (Ian Sturton)
1 *Depth charge rack (9 charges)* **2** *Twin 127 mm (5 in)/38 Mk 38 guns* **3** *Twin Oerlikon 35 mm/90 (on flight deck in D 349 and D 350; on foredeck in D 345)* **4** *Eight Harpoon SSM launchers (not in D 345)* **5** *ASROC Mk 112 octuple launcher* **6** *SPS-10 radar (surface search)* **7** *SPS-40 radar (air seach)* **8** *Triple Mk 32 torpedo tubes*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Turkey
Type: Gearing class (FRAM I)

Class: YUCETEPE

Acquired: 10
Active: 3

Displacement:
standard: 2,425 t
full load: 3,500 t

Dimensions
Length: 119 m (390.5 ft)
Beam: 12.6 m (41.2 ft)
Draught: 5.8 (19 ft)

Speed: 32.5 kts
Range: 5,800 n miles at 15 kts; 2,400 n miles at 25 kts

Complement: 275 (15 officers)

SHIPS

YUCETEPE (D 345)	
Builder	Consolidated Steel Corporation, Orange, Texas, USA
Laid down	28 Nov 1944
Launched	12 May 1945
Commissioned (US Navy)	15 Sep 1945 (*Orleck* (DD 886))
Recommissioned	25 Dec 1982
Sold to Turkey	June 1987

KILIC ALI PASA (D 349)	
Builder	Consolidated Steel Corporation, Orange, Texas, USA
Laid down	26 Jun 1945
Launched	9 Nov 1945
Commissioned (US Navy)	26 Oct 1946 (*Robert H. McCard* (DD 822))
Recommissioned	5 June 1980
Sold to Turkey	June 1987

PIYALE PASA (D 350)	
Builder	Bath Iron Works, Bath, Maine, USA
Laid down	9 Apr 1945
Launched	8 Sep 1945
Commissioned (US Navy)	28 Nov 1945 (*Fiske* (DD 842))
Recommissioned	5 Jun 1980
Sold to Turkey	June 1987

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas RGM-84B Harpoon

DD 349 and DD 350 only have eight Harpoon anti-ship missile canisters mounted on the former flight deck. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 kg)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

There is a single Mk 112 ASROC launcher, located between the stacks, with eight reloads. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target, including submarines with anechoically coated hulls, and has an estimated acquisition range of 460 m.

When a submarine target is detected, it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (200-1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m. On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and, as they separate, the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications

ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.25 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)

Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor
Honeywell Training and Control Systems, West Covina, California.

TUBES

Two triple 324 mm US Mk 32 torpedo tubes are sited forward in the 'B' gun position.

Specifications
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

Alliant Techsystems Mk 46 Mod 5 324 mm torpedoes

Specifications
Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507.0 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

GUNS

Mk 38 127 mm (5 in) L/38 gun mounting
There are two Mk 38 twin mountings in 'A' and 'Y' positions, each with two Mk 12 guns. Shells are loaded manually into a hydraulically powered ramming tray and the mount can be worked in manual, local or remote control. With automatic control it is operated by a remote fire-control system by means of indicator regulators on the single training gear assembly and the single elevating assembly. Each gun has its own projectile and propellant hoists, with the projectile hoist lift pawls also acting as fuze setters. The mounting requires 13 men within the armoured shield and 14 in the magazines. The approximate life of each barrel is 4,600 EFC (Equivalent Full Charges).

Specifications
Calibre: 127 mm (5 in)
Length of barrel: 38 calibres
Muzzle velocity: 792 m/s (new gun), 762 m/s (mid-life)
Range: 13.5 n miles (25.26 km)
Altitude: 12,836 m (42,000 ft)
Weight of shell: 24.95 kg (55 lb)
Traverse: ±164° at 25°/s
Elevation: −15 to +85° at 15°/s
Rate of fire: 36 rds/min

Oerlikon 35 mm GDM-C mounting
Secondary armament consists of one twin Oerlikon 30 mm mounting; this is in 'B' gun position in *Yucetepe* (D 345) and on the flight deck in the other two. The manned GDM-C mounting is deck-mounted, with two KDA guns on a shared cradle. The firing platform runs on ball bearings with the trunnion walls together with trunnion bearings. On either side of the elevating mass are two magazine feeding devices each with 56 rounds in seven rows. Each device, which is powered by a spring motor, uses two vertical and one horizontal hoists to move the layers of ammunition down and across through the ring-shaped trunnions to the breech. Two reserve ammunition boxes, each with 112 rounds, are available and there is an operator's position which may be open or protected by a plastic cupola. The mounting has thyristor control with power demands for both training and elevation individually set by an adjustable current-limiting device for efficiency. The biaxially stabilised mounting is 2.75 m high. The GDM-C may be locally or remotely operated and features three operational modes; automatic, local control and emergency local control.

Specifications
Gun
Calibre: 35 mm
Length of barrel: 90 calibres
Muzzle velocity: 1,175 m/s (3,855 ft/s)
Rate of fire: 550 rds/min/per barrel
Ammunition: 1.56 kg
Range: 2.7 n miles/5 km (surface-to-surface), 4,500 m (air defence)

Mounting GDM-C
Loaded weight: 6.52 t
Traverse: 360°
Elevation: −15 to +85°
Training speed: 120°/s
Elevation speed: 100°/s
Crew: 3, 1 gunner, 2 loaders

Manufacturer/Contractor
Oerlikon Contraves, Zurich, Switzerland.

Kilic Ali Pasa *(D 349) showing depth charges on the stern, the aft twin 127 mm (5 in)/38 Mk 38 turret and above it the Oerlikon twin 35 mm mounting. The three black domes on the mainmast are elements of the ULQ-6 ECM system* (H & L van Ginderen Collection)

DEPTH CHARGES

There is one rack, carrying nine depth charges.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES (ECM)

OTOBREDA 105 mm Rocket Launcher (SCLAR)
There are two or four 20-tube launchers. Most are believed to be OTOBREDA 105 mm SCLAR Mk 2 launchers, although some may be SRBOC. Details of SCLAR follow. SCLAR 105 mm rocket launcher system provides defence against radar and IR homing missiles, confuses enemy radars, and provides illumination for visual fire control at night. Different types of rockets can be loaded in various arrangements (long-range chaff, medium-range chaff, illuminating) to permit mixed salvos. The remote fire-control unit is used to select the number and types of rockets to be loaded and to set the fuzes and carry out the launch sequence. The control unit is linked to the ship's radar with a control panel in the ECM compartment to provide the necessary operating signals. The data needed to stabilise the two launchers against pitch and roll is provided by the

ship's gyrocompass. There are four types of rocket, all of which have double-base propellant motors, folding fins and electronic fuzes, while their speed to burnout is 260-645 m/s. These rockets are:

Specifications
Traverse: 300° at 60°/s
Elevation: −5 to +60° at 30°/s
Diameter: 105 mm
Rate of fire: 1 rd/s (approx)

Rocket	Role	Range	Length	Weight of complete round	Payload
SNIA 105 LR-C	Chaff distraction	12,000 m	1.85 m	27 kg	10.2 kg
SNIA 105 MR-C	Chaff seduction	4,700 m	1.83 m	29 kg	17.4 kg
SNIA 105 MR-IR	Infra-red seduction	5,000 m	1.83 m	29 kg	
SNIA LR-I	Illuminating	4,000 m	1.85 m	27 kg	10.2 kg

Manufacturer/Contractor
OTOBREDA, Rome, Italy.

ULQ-6
ULQ-6 is a deception jammer which was originally developed to deal with the threat posed by Soviet missiles such as SS-N-2.

ELECTRONIC SUPPORT MEASURES (ESM)

WLR-1
WLR-1 is a US-manufactured, manually operated, radar warning system covering frequencies from 50 MHz to 10.75 GHz, employing a number of separate antennas.

WLR-3
WLR-3 is a 1950s-vintage radar warning receiver.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Mk 37 GFCS
The Mk 37 Gun Fire Control System (GFCS) is used for the 127 mm guns and is a Second World War vintage system, now only to be seen on elderly ex-US Navy destroyers, such as this. The director incorporates a 4.6 m (15 ft) stereoscopic rangefinder and a Mk 25 H/I-band radar.

Mk 51 GFCS
There are either one or two Mk 51 Mod 2 Gun Fire Control Systems (GFCS) 35 mm mountings. It includes a Mk 26, E/F-band, range-only radar. Maximum tracking range is 25,000 m.

SONAR

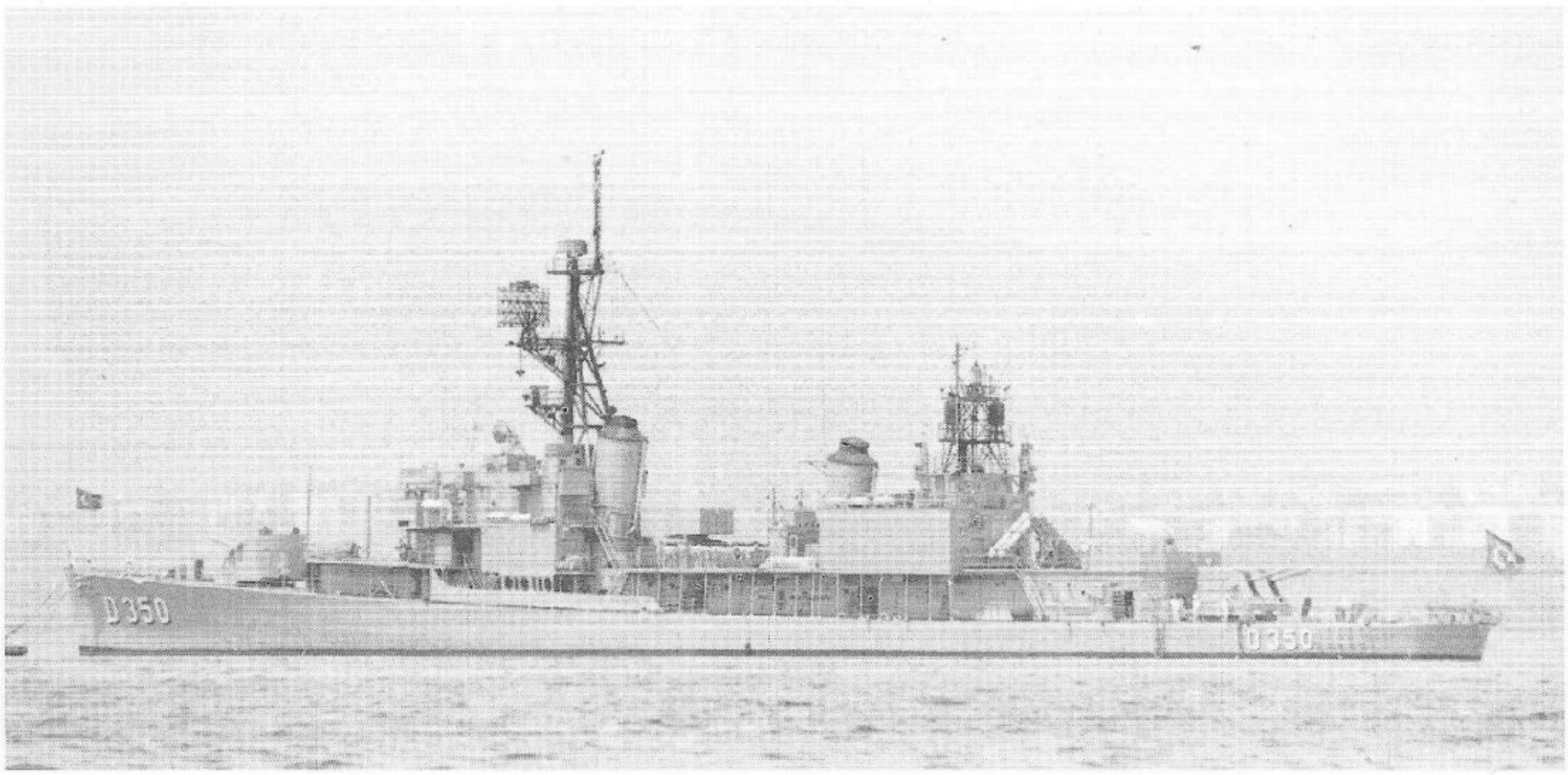
Sangamo AN/SQS-23
AN/SQS-23 is a hull-mounted, active search and attack sonar, operating at low frequency, and is the sonar designed to operate with the ASROC system. The array is cylindrical and has 48 staves, each with two transducers.

Specifications
Frequency: 4.5/5/5.5 kHz
Pulse length: 5/30/50 ms
Nominal range: 14,000 m (15,000 yd)

RADARS

Set	SPS-40	SPS-10	(See note)	Mk 25 (Mk 37 GFCS)
Company	Lockheed	Raytheon/Sylvania	Racal Decca	Western Electric
Role	Air search	Surface search	Navigation	Fire Control
Band	E/F	G	I/J	I/J
Range	175 n miles (320 km)	—	—	91,000 m
Beam	1.5 × 16°	1.5 × 16°		1.6°
Peak power	500 kW	500 kW		250 kW
Gain	30 dB	30 dB		39 dB
Pulsewidth	0.25/1.3 µs	0.25/1.3 µs		0.25 µs
PRF	650 pps	650 pps		1,320 pps
Scan rate	15 rpm	15 rpm		—

Note
The actual type of radar set is not known.



Turkish Piyale Pasa *(D 350) the former United States* Fiske *(DD 842), launched on 8 September 1945. The former flight deck now carries a twin Oerlikon 35 mm GDM-C mounting and eight Harpoon missile launchers (only four are installed in this picture)* (H & L van Ginderen Collection)

Kilic Ali Pasa *(D 349)* (NATO/HQ AFSOUTH)

PROPULSION

Specifications
System: Steam-turbines
Main machinery: 4 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 General Electric turbines; 45 MW (60,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

A total of ten 'Gearing' class destroyers was transferred to Turkey between 1971 and 1982. One ship, *Kocatepe* (ex-USS *Harwood* (DD 861) was sunk on 22 July 1974 during the landings in Cyprus by fighters of the Turkish Air Force, whose pilots mistook it for a Greek Navy 'Gearing' class destroyer. A ship which had been bought for cannibalisation (ex-*Meredith* (DD 890)) was hastily refitted and returned to service with the same name and hull number as the ship that had been lost.

Seven have been stricken, leaving three in service.

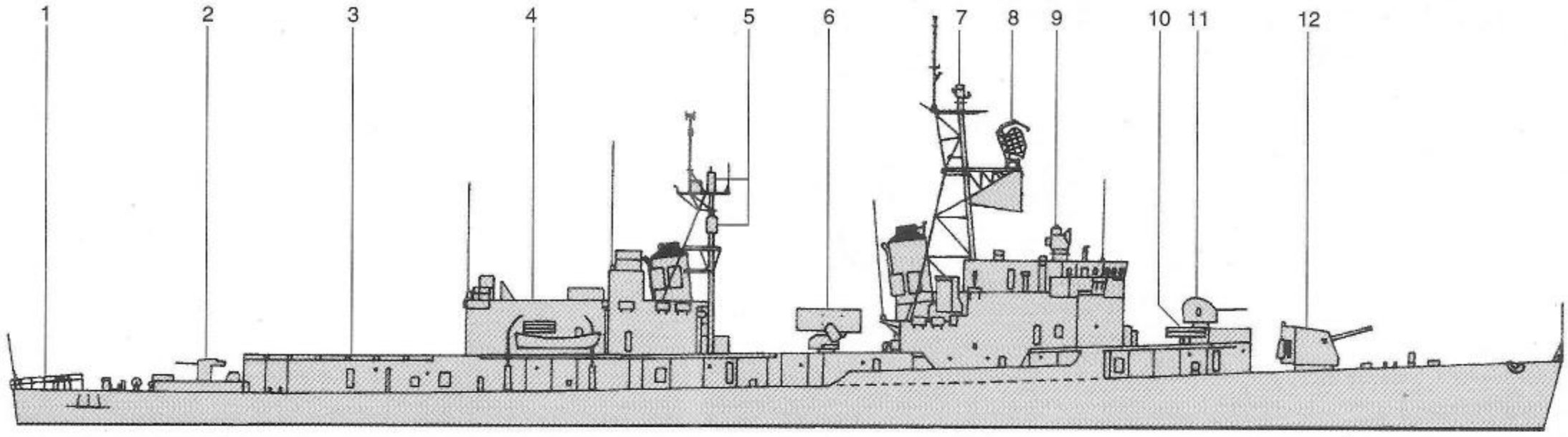
MODERNISATION

Two of the ships were FRAM II conversions, all the remainder were FRAM Is. They have all been given various updates during their Turkish service and there have always been minor differences in armaments and sensors. At one stage it was planned to fit Sea Sparrow VLS in four of the class, but this has been cancelled.

All had a DASH helicopter platform and hangar at the time they were transferred, but most have had guns of various types installed on the flight deck. Only D 345 retains a flight deck capable of helicopter operations.

Yucetepe *(D 345). Alone among these three ships,* Yucetepe *has the twin Oerlikon 35 mm mounting forward in 'B' position* (H & L van Ginderen Collection)

ALCITEPE (CARPENTER)



Alcitepe (Ian Sturton)
1 *Depth charge rack (9 charges)* **2** *Twin 76 mm (3 in)/50 (open mount)* **3** *Flight deck (can accept AB 212 ASW helicopter)* **4** *Hangar (not large enough for helicopter)* **5** *ULQ-6 ESM/ECM* **6** *Mk 112 octuple ASROC launcher* **7** *SPS-10 radar (surface search)* **8** *SPS-40 radar (air search)* **9** *Mk 36 gunfire control system* **10** *Triple Mk 32 324 mm torpedo tubes* **11** *Oerlikon twin 35 mm/90 cannon* **12** *Twin 127 mm (5 in)/38 Mk 38 mounting*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Turkey
Type: Carpenter (FRAM I)

Class: ALCITEPE

Acquired: 2
Active: 2

Displacement:
standard: 2,425 t
full load: 3,540 t

Dimensions
Length: 119 m (390.5 ft)
Beam: 12.5 m (41 ft)
Draught: 6.4 m (20.9 ft)

Speed: 33 kts
Range: 6,000 n miles at 12 kts

Complement: 275 (15 officers)

SHIPS

ALCITEPE (D 346)	
Builder	Bath Iron Works, Bath, Maine, USA
Laid down	29 Oct 1945
Launched	15 Jul 1946
Commissioned (US Navy)	5 Nov 1949 (*Robert A Owens* (DD 827))
Recommissioned	20 Jul 1982

ANITTEPE (D 347)	
Builder	Consolidated Steel, Orange, Texas, USA
Laid down	30 Jul 1945
Launched	30 Dec 1945
Commissioned (US Navy)	15 Dec 1949 (*Carpenter* (DD 825))
Recommissioned	15 Jun 1981

WEAPONS SYSTEMS

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

There is a single Mk 112 ASROC launcher, located between the stacks, with eight reloads. ASROC consists essentially of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target, including submarines with anechoically coated hulls, and has an estimated acquisition range of 460 m.

When a submarine target is detected, it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (200 and 1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m. On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and, as they separate, the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications

ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Wing span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97.0 lb); PBXN-103

Manufacturer/Contractor

Honeywell Training and Control Systems, West Covina, California.

TUBES

Two triple 324 mm US Mk 32 torpedo tubes are sited forward in the 'B' gun position.

Specifications

Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

Alliant Techsystems Mk 46 Mod 5 324 mm torpedoes

Specifications

Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507.0 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

GUNS

Mk 38 127 mm (5 in) L/38 gun mounting

There is one Mk 38 twin mounting in 'A' position, with two Mk 12 guns. Shells are loaded manually into a hydraulically powered ramming tray and the mounting is are worked in manual, local or remote control. With

Carpenter *(DD 825) in its original state in 1946. Forward of the bridge are Weapons Alpha, a trainable Hedgehog ASW launcher, and an open twin 76 mm (3 in) mounting. This ship, launched on 30 December 1945 is still in service, albeit much modified, as the Turkish* Anittepe *(D 347)* (Jane's)

automatic control it is operated by a remote fire-control system by means of indicator regulators on the single training gear assembly and the single elevating assembly. Each gun has its own projectile and propellant hoists, with the projectile hoist lift pawls also acting as fuze setters. The mounting requires 13 men within the armoured shield and 14 in the magazines. The approximate life of each barrel is 4,600 EFC (Equivalent Full Charges).

Specifications
Calibre: 127 mm (5 in)
Length of barrel: 38 calibres
Muzzle velocity: 792 m/s (new gun), 762 m/s (mid-life) (2,600/2,500 ft/s)
Range: 13.5 n miles (25.26 km)
Altitude: 12,836 m (42,000 ft)
Weight of shell: 24.95 kg
Traverse: ±164° at 25°/s
Elevation: −15 to +85° at 15°/s
Rate of fire: 36 rds/min

Mk 33 76.2 mm (3 in) L/50 mounting
Both ships have one Mk 33 open mounting, with two 76.2 mm (3 in) 50-calibre Mk 21 gun tubes in 'Y' position. The barrels are 4.05 m long, weigh 798 kg and have a life of 4,300 rounds EFC (Equivalent Full Charges). The associated gun fire control system is the Mk 56 The guns use a fixed 10.9 kg round with a 5.9 kg projectile which includes 1.68 kg of nitro-cellulose propellant.

Specifications
Gun
Calibre: 76.2 mm
Length of barrel: 50 calibres
Muzzle velocity: 823 m/s (new gun, nominal); 808 m/s (mid-life) (2,700/2,650 ft/s)
Range: 7 n miles (13 km)
Altitude: 8,951 m (30,000 ft)
Ammunition: 10.9 kg (24 lb)

Mounting (Mk 33)
Traverse: 360°
Elevation: −15° to +85°
Traverse rate: 30°/s
Elevation rate: 24°/s
Rate of fire: 100 rds/min

Oerlikon 35 mm GDM-C mounting
Secondary armament consists of one twin Oerlikon 30 mm mounting in 'B' gun position. The manned GDM-C mounting is deck-mounted, with two KDA guns on a shared cradle. The firing platform runs on ball bearings with the trunnion walls together with trunnion bearings. On either side of the elevating mass are two magazine feeding devices each with 56 rounds in seven rows. Each device, which is powered by a spring motor, uses two vertical and one horizontal hoists to move the layers of ammunition down and across through the ring-shaped trunnions to the breech. Two reserve ammunition boxes, each with 112 rounds, are available and there is an operator's position which may be open or protected by a plastic cupola. The mounting has thyristor control with power demands for both training and elevation individually set by an adjustable current-limiting device for efficiency. The biaxially stabilised mounting is 2.75 m high. The GDM-C may be locally or remotely operated and features three operational modes; automatic, local control and emergency local control.

Specifications
Gun
Calibre: 35 mm
Length of barrel: 90 calibres
Muzzle velocity: 1,175 m/s (3,855 ft/s)
Rate of fire: 550 rds/min/per barrel
Ammunition: 1.56 kg (3.44 lb)
Range: 2.7 n miles/5 km (surface-to-surface), 4,500 m (air defence)

Mountings GDM-C
Loaded weight: 6.52 t
Traverse: 360°
Elevation: −15 to +85°
Training speed: 120°/s
Elevation speed: 100°/s
Crew: 1 gunner, 2 loaders

Manufacturer/Contractor
Oerlikon Contraves, Zurich, Switzerland.

DEPTH CHARGES

There is one rack holding nine depth charges.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC COUNTERMEASURES (ECM)

WLR-1
WLR-1 is a US-manufactured, manually operated, radar warning system covering frequencies from 50 MHz to 10:75 GHz, employing a number of separate antennas.

ULQ-6
ULQ-6 is a deception jammer which was originally developed to deal with the threat posed by Soviet missiles such as SS-N-2.

Robert A Owen *(DD 827), sister ship to* Carpenter, *after the FRAM conversion. A closed 127 mm (5 in) mount has replaced the open 76 mm (3 in) mount. Weapon Alpha and Hedgehog have disappeared, replaced by two triple 324 mm torpedo tubes. The space between the stacks has been cleared to accommodate an octuple ASROC launcher, while aft, a hangar and flight deck have been installed for the DASH helicopter system* (H & L van Ginderen Collection)

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

Mk 56 GFCS

The Mk 56 GFCS can issue simultaneous gun and fuze-setting orders to two gun mounts of two types; for example, 105 mm (3 in) L/50 and 127 mm (5 in) L/38. It can produce a very fast fire-control solution, typically within 2 seconds of beginning to track. The target is designated through the ship's air and surface search radars and the director is turned in the appropriate direction. By using elevation and traverse error signals when the target moves out of the radar's line-of-sight, the radar antenna is kept on the target. The system uses two computers: Mk 42, for primary and secondary ballistics, and Mk 30 for primary gun orders. These also receive inputs on ship speed and course from the log and gyrocompass as well as target range from the radar. Values are inserted for gun dead time, for initial velocity, true windspeed and wind direction. On the basis of all this data the computers generate training and elevation instructions together with fuze orders for the guns.

Manufacturer/Contractor

General Electric Company, Ordnance Systems Division.

RADARS

Set	SPS-40	SPS-10	(See note)	Mk 35 (Mk 56 GFCS)
Company	Lockheed	Raytheon/Sylvania	Racal Decca	General Electric
Role	Air search	Surface search	Navigation	Fire Control
Band	E/F	G	I/J	I/J
Range	175 n miles (320 km)	—	—	Destroyers at 27.5 km
Beam	1.5 × 16°	1.5 × 16°		6° spiral scan
Peak power	500 kW	500 kW		50 kW
Gain	30 dB	30 dB		
Pulsewidth	0.25/1.3 µs	0.25/1.3 µs		0.1 µs
PRF	650 pps	650 pps		3,000 pps
Scan rate	15 rpm	15 rpm		—

Note Type not known

Mk 114 Fire-Control System

The Mk 114 is the fire-control system for ASW operations. The main element is the Mk 53 Attack Console, an electromechanical analogue system which consists of two major units, the attack plotter and the ballistic computer. The latter conducts weapon presets for both ASROC and ASW torpedoes. The Mk 114 system also includes the Mk 33 underwater fire-control switchboard which accepts data from two Mk 19 gyrocompasses and other sensors, as well as from the Mk 134 sonar stabilisation computer. The consoles have an AN/UYK-44 reconfigurable processor with some 70,000 lines of CMS-2 language code. The system interfaces with the sonar, in this case the bow-mounted Sangamo SQS-23D.

Manufacturer/Contractor

Loral Librascope.

Target Designation System Mk 1

TDS Mk 1 was installed on specialised ASW destroyers in the US Navy in the 1950s. It is a manual system for designating and tracking targets, but could not actually assign targets to weapons systems.

SONAR

Sangamo AN/SQS-23

AN/SQS-23 is a hull-mounted, active search and attack sonar, operating at low frequency, and is the sonar designed to operate with the ASROC system. The array is cylindrical and has 48 staves, each with two transducers.

Specifications

Frequency: 4.5/5/5.5 kHz
Pulse length: 5/30/50 ms
Nominal range: 14,000 m (15,000 yd)

AVIATION

AVIATION FACILITIES

Specifications
Flight deck: 18 × 12.5 m (60 × 41 ft)
Hangar: There is a small hangar but it cannot accommodate an AB 212ASW helicopter

HELICOPTERS

One AB 212ASW.

PROPULSION

Specifications
System: Steam turbine
Main machinery: 4 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 General Electric turbines; 45 MW (60,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

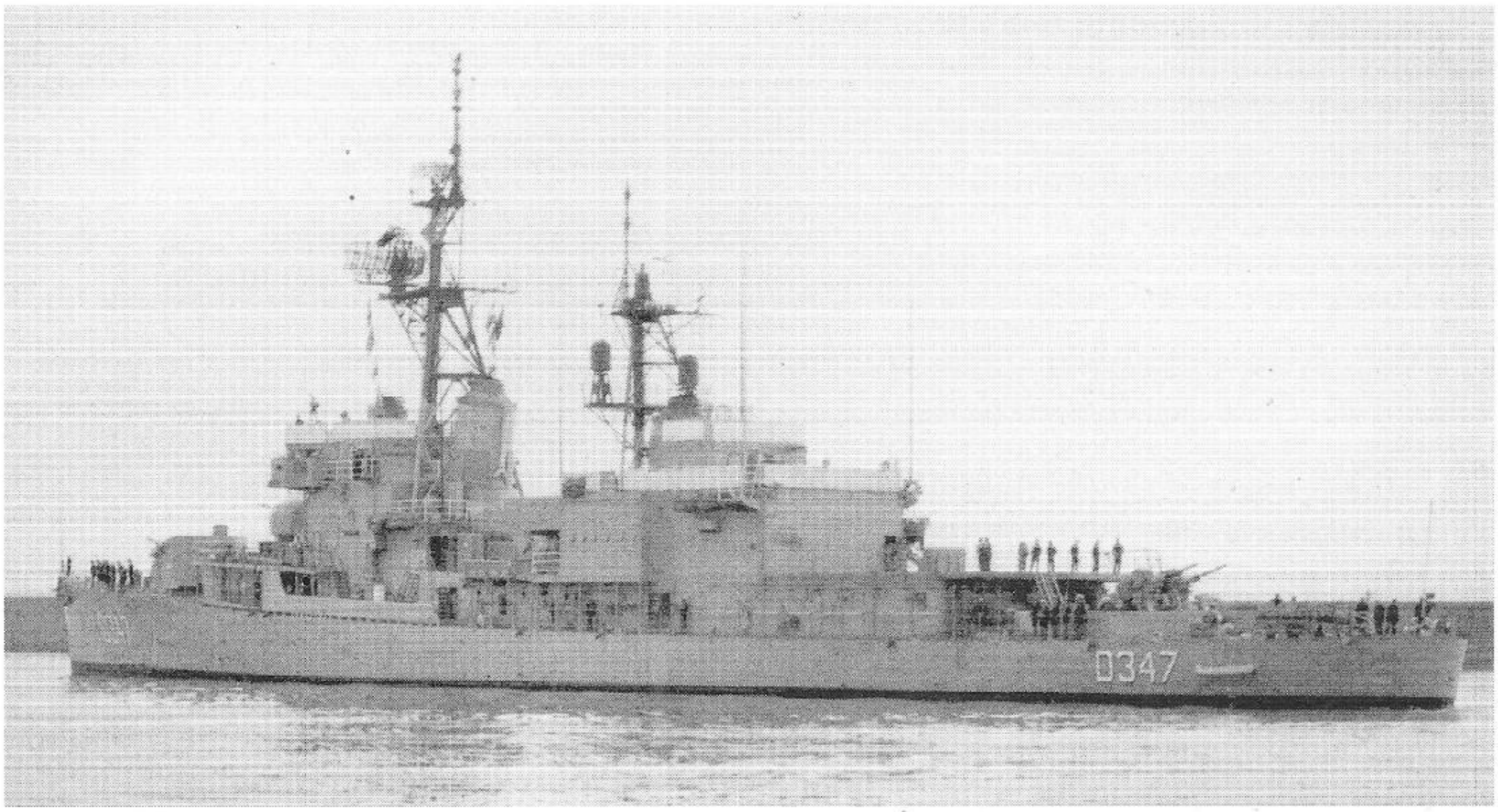
These were two of the four 'Carpenter' class to be completed. They were transferred from the US Navy in 1981/82 and purchased outright in June 1987.

DESIGN

The Carpenters used the Gearing hull and propulsion system but their armament and sensors were optimised for the ASW mission.

MODERNISATION

Earlier plans to fit a SAM system have been cancelled.



Anittepe *(D 347) (the former USS* Carpenter *(DD 825)) as it is today with the closed 127 mm twin mount in 'A' position and the open 76 mm mount in 'Y' position. An AB 212 ASW helicopter can operate from the flight deck, but the hangar is not long enough to accommodate it*

WU CHIN CONVERSIONS

OVERVIEW

The Republic of China Navy (ROCN) received 17 'Gearing' class destroyers from the US Navy between 1971 and 1983. One of these was bought for cannibalisation for spares and a second ran aground while being towed to Taiwan and, after being refloated, was also used as a source of spares. Of the 15 that became operational, 11 were FRAM I conversions and two FRAM II conversions. Even so, there were numerous differences between them, even within these categories, and some were in poor condition when sold to the ROC, three having been rejected by the Spanish Navy prior to being accepted by the RoCN. Two have since been scrapped, leaving 13 in service in 1997.

These 13 remaining ships have all undergone major modernisation programmes whilst in the RoCN, to three standards, known as Wu Chin I, II and III, respectively. Due to pressure from the government in Beijing on potential suppliers, the RoC has considerable difficulty in obtaining defence equipment; it has thus been forced both to develop its own systems and also to take what ever equipment it can obtain from abroad.

The RoCN also received 8 'Allen M Sumner' class destroyers of which six have been stricken. Two remain in service, of which one *(Huei Yang)* is in its original state, but the other *(Nan Yang)* received conversion to 'Wu Chin I' standard, and is included in this section.

The actual conversions are summarised in Table I.

As their current capabilities are more important, they will be treated here according to their Wu Chin status, rather than by their original class (that is, 'Gearing' or 'Allen M Sumner') and status on transfer (that is, FRAM I or II). The principal weapons fits are summarised in Table II, although it should be noted that there are some differences even within the groups, and the main sensors are given in Table III.

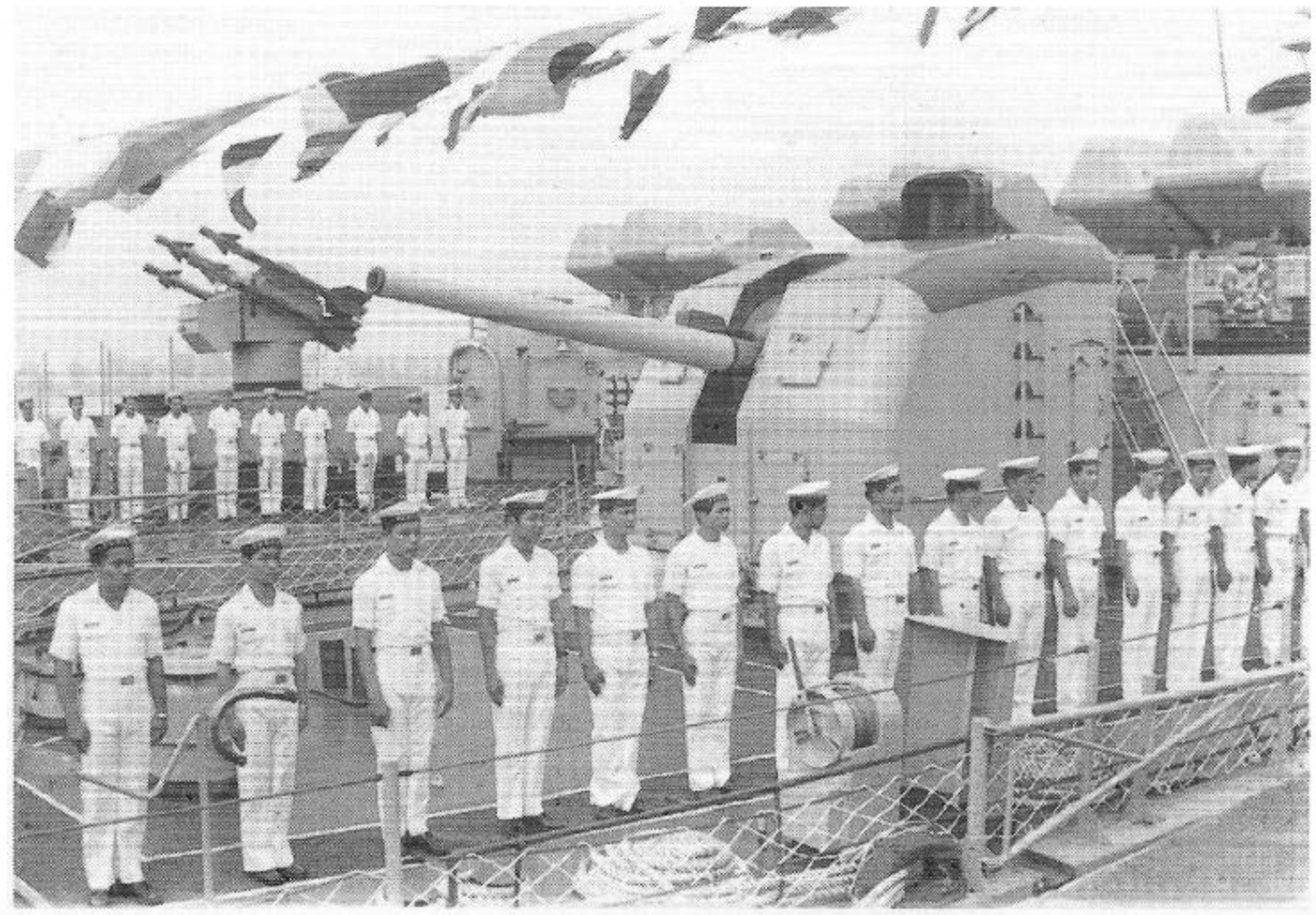
TABLE I: WU CHIN CONVERSIONS

Wu Chin conversion	ROCN ship Name	ROCN ship Number	Original USN Name	Original USN Number	FRAM status
Wu Chin I	*Nan Yang*	917	*John W Thomas*	DD 760	FRAM II
	Fu Yang	907	*Ernest G Small*	DD 838	FRAM II
	Shuei Yang	926	*Hawkins*	DD 873	FRAM I
Wu Chin II	*Dang Yang*	911	*Lloyd Thomas*	DD 764	FRAM II
	Han Yang	915	*Herbert J Thomas*	DD 833	FRAM I
	Lai Yang	920	*Leonard F Mason*	DD 852	FRAM I
	Kai Yang	924	*Richard B Anderson*	DD 786	FRAM I
Wu Chin III	*Chien Yang*	912	*James E Keyes*	DD 787	FRAM I
	Liao Yang	921	*Hanson*	DD 832	FRAM I
	Shen Yang	923	*Hollister*	DD 788	FRAM I
	Te Yang	925	*Sarsfield*	DD 837	FRAM I
	Yun Yang	927	*Johnston*	DD 821	FRAM I
	Chen Yang	928	*Power*	DD 839	FRAM I
	Shao Yang	929	*Hamner*	DD 718	FRAM I

TABLE II: WU CHIN CONVERSIONS — WEAPONS SYSTEMS

		Wu Chin I	Wu Chin II	Wu Chin III
MISSILES	Hsiung Feng I/II	5	5	(Note 1)
	Standard SM-1 MR	—	—	10 (Note 2)
	Sea Chaparral	1	1	—
	ASROC	(Note 3)	—	1
GUNS	127 mm/38 twin turret	2 (2 × 1) (Note 4)	2	—
	OTO Melara 76 mm	1	1	1
	Vulcan Phalanx	—	—	1
	Bofors 40 mm (single or twin)	1/2	1/2	2
	12.7 mm machine-guns	4/6	4/6	4/6
ASW	324 mm (2 × 3) torpedo tubes	6	6	6
	Hedgehog Mk 10 launchers	2 (Note 5)		
HELICOPTER	MD 500	—	1	1

Notes
1. Four Hsiung Feng may be fitted later
2. In individual canister launchers; no reloads
3. *Shuei Yang* only has retained ASROC
4. One twin turret in 'A' position in *Nan Yang*
5. *Nan Yang* only



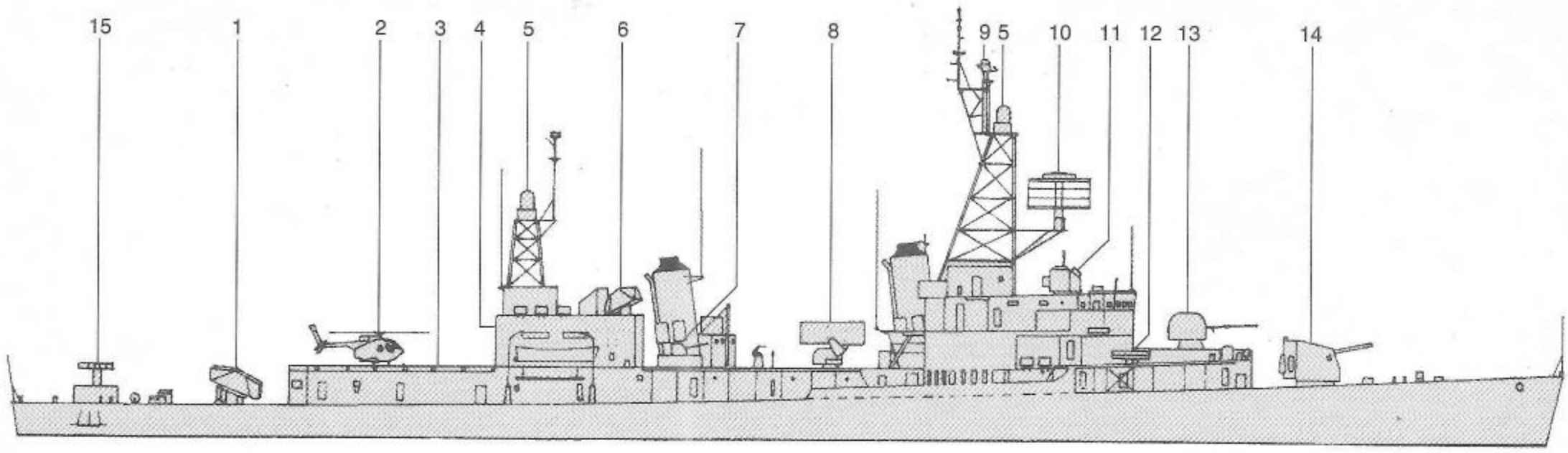
Two Taiwanese destroyers showing some of the weapons involved in the Wu Chin programme. Right are triple launchers for Hsiung Feng anti-ship missiles and on the further ship is a Sea Chaparral launcher. Also involved are US Navy 127 mm (5 in) guns, although most are in twin turrets

TABLE III: WU CHIN CONVERSIONS — SENSORS AND DATA SYSTEMS

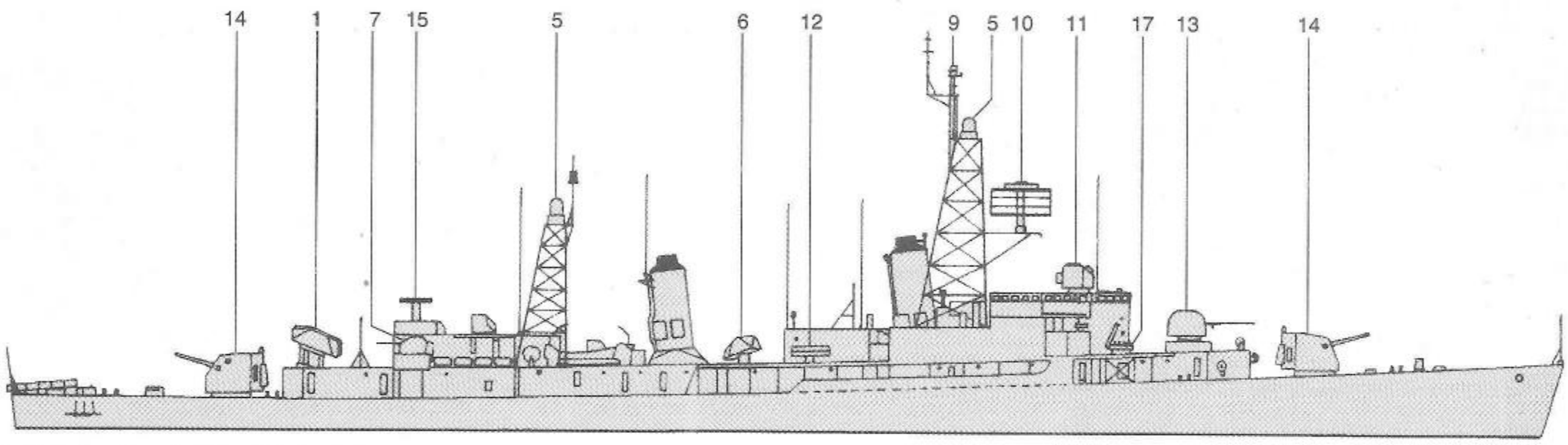
			Wu Chin I	Wu Chin II	Wu Chin III
Counter-measures	Chaff launchers	Kung Fen 6 16-tube	4	4	4
	Torpedo decoy	Mk T-6 Fanfare	1	1	1
ESM/ECM	Radar intercept	WLR-1/-3	✓	✓	
	Jammer	ULQ-6	✓	✓	
	ECM suite	Chang Feng III			✓
Combat data systems	Action data automation	Elbit		✓	
	Datalink	Ta Chen			✓
Weapons control	SSM	Honeywell H-930 (SSM)	✓	✓	✓
	Guns	Mk 37 GFCS (guns)	✓	✓	
	ASROC	Mk 114	✓ (Note 1)		✓
Radar	Air search	AN/SPS-40 or AN/SPS-29	✓	✓	
		Signaal DA 08			✓
	Surface search	SPS-10 or SPS-58 JNW	✓		✓
		Elta 1040		✓	
	Missile control	Mk 25	✓		
		RTN-10X		✓	
	Guns/missiles	RCA HR-76	✓	✓	
		STIR			✓
	40 mm Bofors	Westinghouse W-160			
	Navigation	type unknown	✓	✓	✓

Notes
1. *Shuei Yang* only

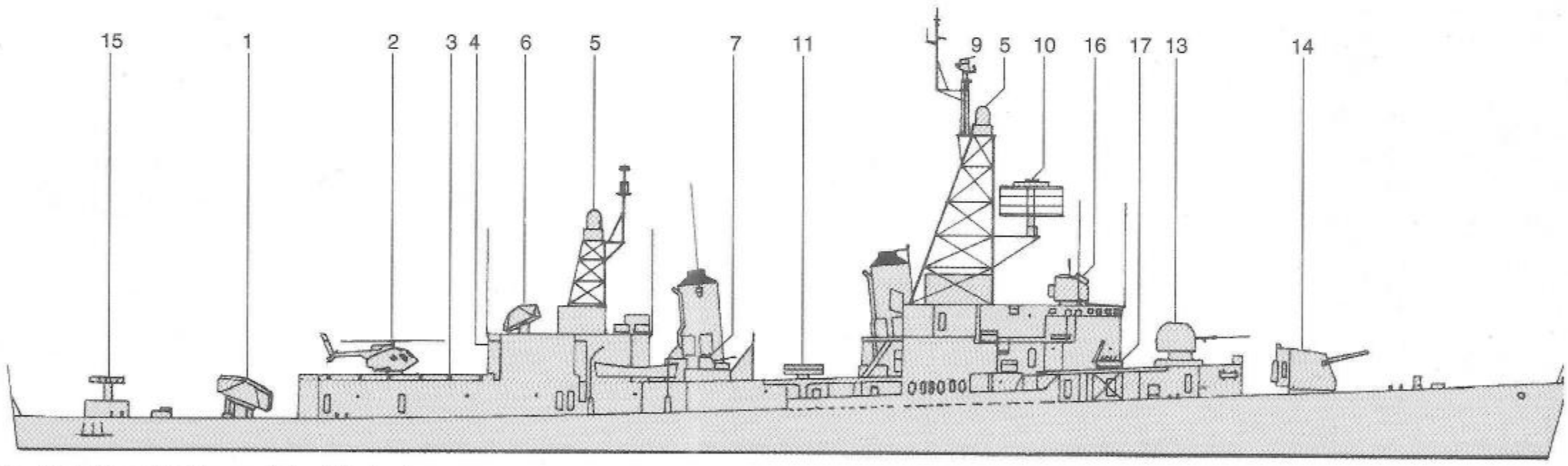
WU CHIN I



Shuei Yang (ex-Gearing) (Ian Sturton)



Fu Yang (ex-Gearing) (Ian Sturton)



Nan Yang (ex-Allen Sumner) (Ian Sturton)
Wu Chin I (Shuei Yang, Fu Yang – ex-Gearing; Nan Yang – ex-Allen M Sumaer)
1 *Triple Hsiung Feng I or II SSM launcher* **2** *McDonnel Douglas MD-500 helicopter* **3** *Flight deck* **4** *Hangar* **5** *HR-76 fire-control director (SSMs and guns)* **6** *Single Hsiung Feng I or II launcher* **7** *Bofors 40 mm cannon* **8** *ASROC Mk 112 eight-cell launcher* **9** *SPS-10/SPS-58 radar (surface search)* **10** *SPS-40 or SPs-29 radar (air search)* **11** *Mk 25 fire-control director* **12** *Triple 324 mm Mk 32 torpedo launcher* **13** *76 mm (3 in) Compact gun mounting* **14** *Twin 127 mm (5 in)/38 Mk 38 gun mounting* **15** *Sea Chaparral launcher (4 Sidewinder SAM)* **16** *Mk 37 GFCS director* **17** *Hedgehog Mk 10 ASW mortar*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Republic of China (Taiwan)
Type: US Gearing/Sumner

Class: WU CHIN I

Active: 3

Displacement:
standard: Gearing conversion – 2,425 t; Sumner conversion – 2,200 t
full load: Gearing conversion – 3,500 t; Sumner conversion – 3,320 t

Dimensions
Length:
Gearing conversion: 119 m (390.5 ft)
Sumner conversion: 114.8 m (376.6 ft)
Beam:
Gearing conversion: 12.6 m (41.2 ft)
Sumner conversion: 12.4 m (40.9 ft)
Draught: 5.8 m (19 ft)

Speed:
Gearing conversion: 32.5 kts
Sumner conversion: 34 kts
Range:
Gearing conversion: 5,800 n miles at 15 kts
Sumner conversion: 1,000 n miles at 32 kts

Complement: 275 approx

SHIPS

Gearing conversions

FU YANG (907)

Builder	Bath Iron Works, Bath, Maine, USA
Laid down	30 Jan 1945
Launched	14 Jun 1945
Commissioned (US Navy)	21 Aug 1945 (*Ernest G Small* (DD 838))
Converted to radar picket (DDR)	1951
Converted to FRAM II	1961
Sold to Taiwan	5 Feb 1971

SHUEI YANG (926)

Builder	Consolidated Steel Corporation, Orange, Texas, USA
Laid down	14 May 1944
Launched	7 Oct 1944
Commissioned (US Navy)	10 Feb 1945 (*Hawkins* (DD 873))
Converted to FRAM I	1961
Sold to Taiwan	10 Mar 1978

Sumner conversion

NAN YANG (917)

Builder	Bethlehem Steel, San Francisco, California, USA
Laid down	21 Nov 1944
Launched	30 Sep 1944
Commissioned (US Navy)	11 Oct 1945 (*John W Thomas* (DD 760))
Converted to FRAM II	1961
Sold to Taiwan	6 May 1974

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Hsiung Feng IA short/medium-range anti-ship missile

There are one triple and two single launchers for Hsiung Feng IA anti-ship missiles. Hsiung Feng IA is a short-range anti-ship missile, derived from the Israeli Gabriel, powered by a turbojet cruise engine, with rocket boosters for take-off. The fire-control system is similar to that used in Gabriel with a radar tracker (usually HR 76), a display control and processing unit, a vertical reference unit and an optical sight which is usually the Kollmorgen Mk 35 or Model 985. The launcher-containers are also identical to those used in Gabriel and are generally similar to the Harpoon's Mk 141.

The launcher operation is likely to follow that of most conventional medium-range anti-ship missiles with the target acquired by long-range surface search radars with over-the-horizon targeting facilities through a Ta Chen datalink. The launcher and target locations are inserted into the inertial guidance system, the missile is launched and adopts a low-level cruising altitude. The target is acquired by both the radar and the IR sensors and the returns are compared with an onboard library. If significant deviations in one sensor's returns occur then the guidance system assumes it is being jammed and gives priority to the other as the missile enters the sea-skimming terminal phase.

Specifications
(Hsiung Feng IA)
Length: 3.9 m
Diameter: 34 cm
Wing span: 1.35 m
Weight: 540 kg
Speed: Mach 0.9
Range: 19 n miles (36 km)
Guidance: Semi-active radar, IR, manual
Warhead: 150 kg HE
Engine: Microturbo TRI-60 single spool turbojet

SURFACE-TO-AIR MISSILES (SAM)

Loral RIM-72C Sea Chaparral

The Sea Chaparral launcher is sited on the quarterdeck. The Chaparral system was originally developed for the US Army and consists of a manned Mk 54 mounting with two rails on each side, each of which carries a single Sidewinder SAM. In addition to the four missiles on the mounting there are 16 reloads in a magazine. The rails elevate from −9 to +90°.

The Sidewinder missile has an all-aspect IR seeker, a blast fragmentation warhead, and is powered by a single-stage, solid propellant rocket motor.

The operator sits in an air conditioned cab with controls for activating the system, selecting the missile and initiating the launch sequence. Early warning of the target is provided by the ship's radar and the CIC directs the operator to which direction he should turn the mounting. He acquires the target optically, tracks it and selects and activates a missile for the engagement. When the missile's IR detector has acquired the target, an audio tone sounds and the operator launches the missile. Proportional navigation guidance commands are generated from seeker tracking rates and used to control the missile's flight path.

Sea Chaparral is only in service with the RoCN.

Specifications
Length: 2.91 m (9.55 ft)
Diameter: 12.7 cm (5 in)
Wing span: 63 cm (24.8 in)
Weight: 86.2 kg (190 lb)
Speed: Mach 1.2
Range: 4.75 n miles (9 km)
Guidance: Optical aiming, infrared homing
Warhead: Picatinny Arsenal M-250 12.6 kg HE blast-fragmentation
Motor: Hercules/Atlantic Research Corporation M-121 single-stage, solid propellant rocket motor

Manufacturer/Contractor
Loral, Aeronutronic.

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

***(Shuei Yang* only)** Alone among the Wu Chin I conversions, *Shuei Yang* has retained its ASROC Mk 112 launcher, which is located just abaft the forward stack. ASROC consists of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo which has a seeker designed specifically to detect most types of target, including submarines with anechoically coated hulls, and has an estimated acquisition range of 460 m.

When a submarine target is detected it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to

Shuei Yang *(926). From the forward stack aft, the armament includes ASROC Mk 112 eight-cell launcher, Bofors 40 mm (on platform), two single Hsiung Feng launchers (either side of after stack), triple Hsiung Feng launcher (on quarterdeck) and Sea Chaparral SAM launcher. Note the HR 76 director at both mastheads*
(H & L van Ginderen Collection)

Shuei Yang *(926). Forward view of the ship shows triple 324 mm torpedo launchers and OTOBREDA 76 mm (3 in) gun in 'B' position, with twin 127 mm (5 in) gun in 'A' position. On the foremast (from the top) are: TACAN, SPS-10 surface search, HR 76 fire-control radar and the large rectangular array of the SPS-40/29 air search radar. Although the hulls are old, the weapons and the command system are relatively modern* (H & L van Ginderen Collection)

the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (200-1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (1,970 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and, as they separate, the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a pre-determined pattern.

Specifications

ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Wing-span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor

Honeywell Training and Control Systems, West Covina, California.

TUBES

Two triple 324 mm US Mk 32 torpedo tubes are sited abreast the bridge (*Shuei Yang* and *Nana Yang*) or between the stacks *(Fu Yang)*.

Specifications

Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

Alliant Techsystems 46 Mod 5 324 mm torpedoes

Specifications

Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507.0 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

GUNS

Mk 38 127 mm (5 in) L/38 gun mounting

All three ships have one twin Mk 38 mounting on the foredeck in 'A' position, but *Fu Yang* only also has a second mounting on the afterdeck in 'D' position. The Mk 38 mountings use two Mk 12 guns, with shells being loaded manually into a hydraulically powered ramming tray. With automatic control the mounting is operated by a remote fire-control system by means of indicator regulators on the single training gear assembly and the single elevating assembly. Each gun has its own projectile and propellant hoists, with the projectile hoist lift pawls also acting as fuze setters. The mounting requires 13 men within the armoured shield and 14 in the magazines. The approximate life of each barrel is 4,600 EFC (Equivalent Full Charges).

Specifications

Calibre: 127 mm
Length of barrel: 38 calibres
Muzzle velocity: 792 m/s (new gun), 762 m/s (mid-life) (2,600, 2,500 ft/s)
Range: 13.5 n miles (25.26 km)
Altitude: 12,836 m (42,000 ft)
Weight of shell: 24.95 kg (55 lb)
Traverse: ±164°
Elevation: −15 to +85°
Traverse rate: 25°/s
Elevation rate: 15°/s
Rate of fire: 36 rds/min

OTOBREDA 76 mm (3 in)/62 Compact

All three ships have a single OTOBREDA 76 mm (3 in)/62 calibre Compact mounting in 'B' position.

Specifications

Elevation: −15 to +85°
Training speed: 70°/s
Elevation speed: 40°/s
Weight (unloaded): 12 t
Muzzle velocity: 900 m/s (2,952 ft/s)
Rate of fire: 85 rds/min
Range: 8.5 n miles (15.75 km)
Weight of shell: 6 kg (13 lb)

Bofors 40 mm/70

Fu Yang has two twin Bofors 40 mm abreast the after end of the former DASH hangar, while *Shuei Yang* and *Nan Yang* have a single Bofors 40 mm mounting either side of the after stack.

Specifications

Traverse: 360° (nominal) at 90°/s
Elevation: −3 to +85° at 60°/s
Rate of fire: 300 rds/min
Muzzle velocity: 1,005-1,025 m/s (3,297-3,363 ft/s)
Max range:
anti-surface: 6.5 n miles (12 km)
anti-air: 2.2 n miles (4,000 m)
Ammunition weight: 2.4 kg (5.29 lb)
Projectile weight: 0.96 kg (2.11 lb)
Crew: 4

M2HB 12.7 mm (0.50 in) machine guns

All ships carry either four or six M2HB 12.7 mm machine guns, which can be mounted on the ship's rails on flexible mounts.

Specifications

Calibre: 12.7 mm (0.50 in)
Rate of fire: 450-550 rds/min
Muzzle velocity: 883 m/s (2,900 ft/s)
Max effective range:
anti-surface: 6,700 m (7,400 yd)
anti-air: 1,380 m (4,500 ft)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

WLR-1

WLR-1 is a US-manufactured, manually operated, radar warning system covering frequencies from 50 MHz to 10.75 GHz, employing a number of separate antennas.

WLR-3

WLR-3 is a 1950s-vintage radar warning receiver.

ELECTRONIC COUNTERMEASURES (ECM)

ULQ-6

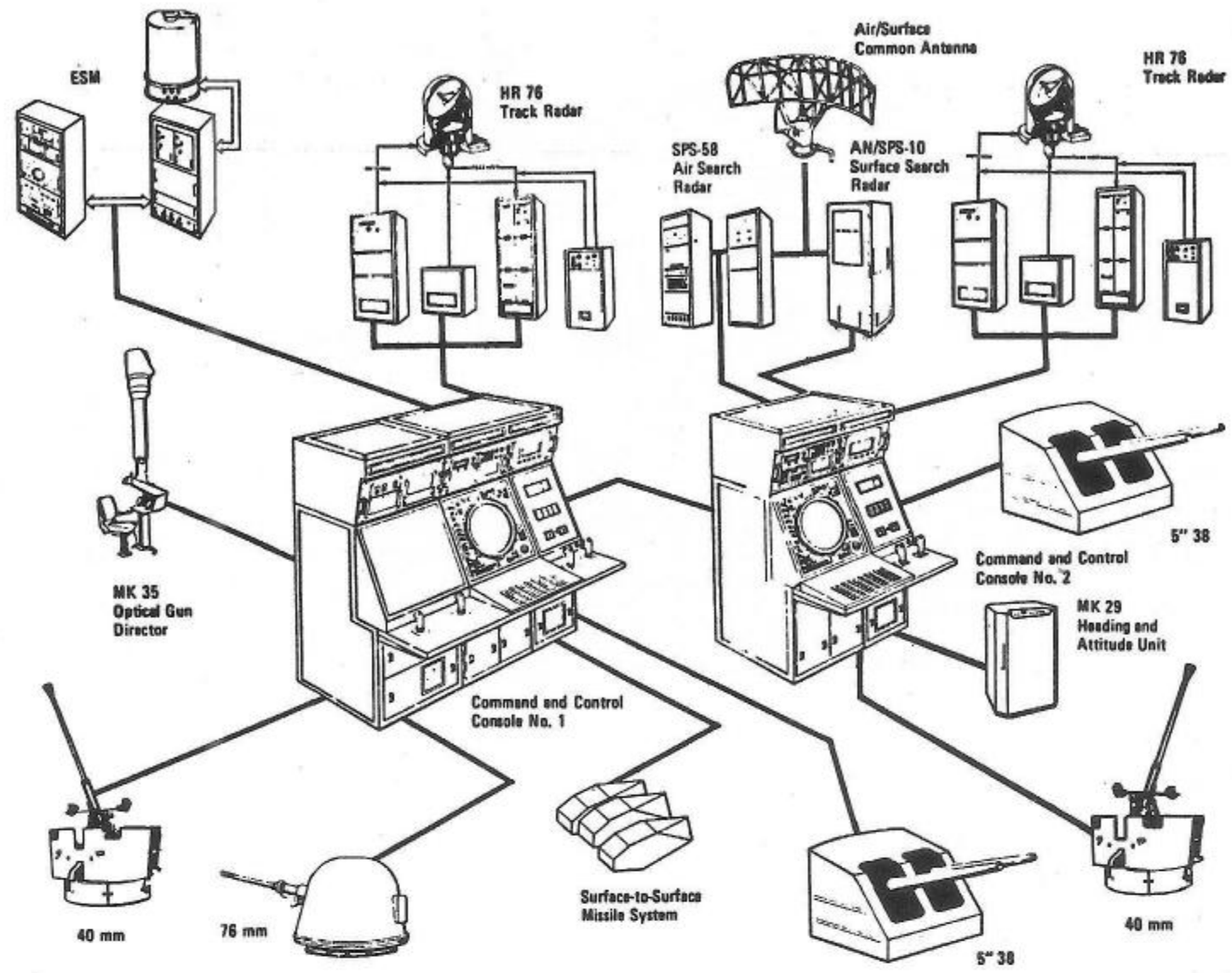
ULQ-6 is a deception jammer which was originally developed to deal with the threat posed by Soviet missiles such as SS-N-2.

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

Chang Feng III ESM/ECM suite

The RoCN's Chang Feng III EW suite is based on the US Navy's AN/SLQ-17 and provides the appropriate threat detection and jamming techniques to counter threats. The system is intended to protect ships against cruise missiles and other intruders by generating an electronic 'image' of the target ship as it is sensed by the enemy's guidance radar and then offsetting that image so that the incoming missile guides itself to the 'ghost' target which is some distance away.

The system detects and tracks signals of several score missiles of many types, and will track up to several hundred signals from other platforms. It keeps track of signals used for navigation, search, and tracking, and can intercept and track potential missile launch platforms beyond the ranges at which the attacking missiles lock on to the ship. As a signal is received, Chang Feng III automatically measures the radar parameters emitted and the computer searches its memory files to separate friend from foe. If it identifies the signal as hostile, it generates the most effective deception, which will cause the missile to strike the ocean at a safe distance.



The H-930 Mod 1 was specifically developed for the RoCN Wu Chin I *and* II *destroyers*

Manufacturer/Contractor

Hughes Aircraft Company, Fullerton, California, USA.

DECOYS

CR-201 decoy rocket system

CR-201 is a decoy system with four launchers per ship, two mounted abreast the after stack and two on the quarterdeck. CR-201 is carried by all RoC Navy destroyers and frigates and consists of four launchers, each with 16 126 mm (5 in) tubes. There are two types of round: one is for long-range distraction and the other is for short-range break-lock.

T-Mk 6 Fanfare

The T-Mk 6 torpedo decoy consists of two winches each with a cable and a 'fish' containing a mechanical acoustic device. It was introduced into the US Navy in the 1950s and was replaced in most ships by AN/SLQ-25 Nixie.

COMMAND AND CONTROL SYSTEMS

WEAPONS CONTROL

H-930 Mod 1 command and weapon control system

The H-930 command and weapon control system is designed to interface with guns and missiles and has a federated architecture based upon Rolm AN/UYK-19 Model 1664 mini-computers which are housed in the display consoles and linked by a databus. The system uses the Algol language software and 30,000 lines of code. The sensor combinations associated with Mod 1 are as follows:

- air search radar: AN/SPS-58
- surface search radar: AN/SPS-10
- fire-control radar: HR-76
- datalink

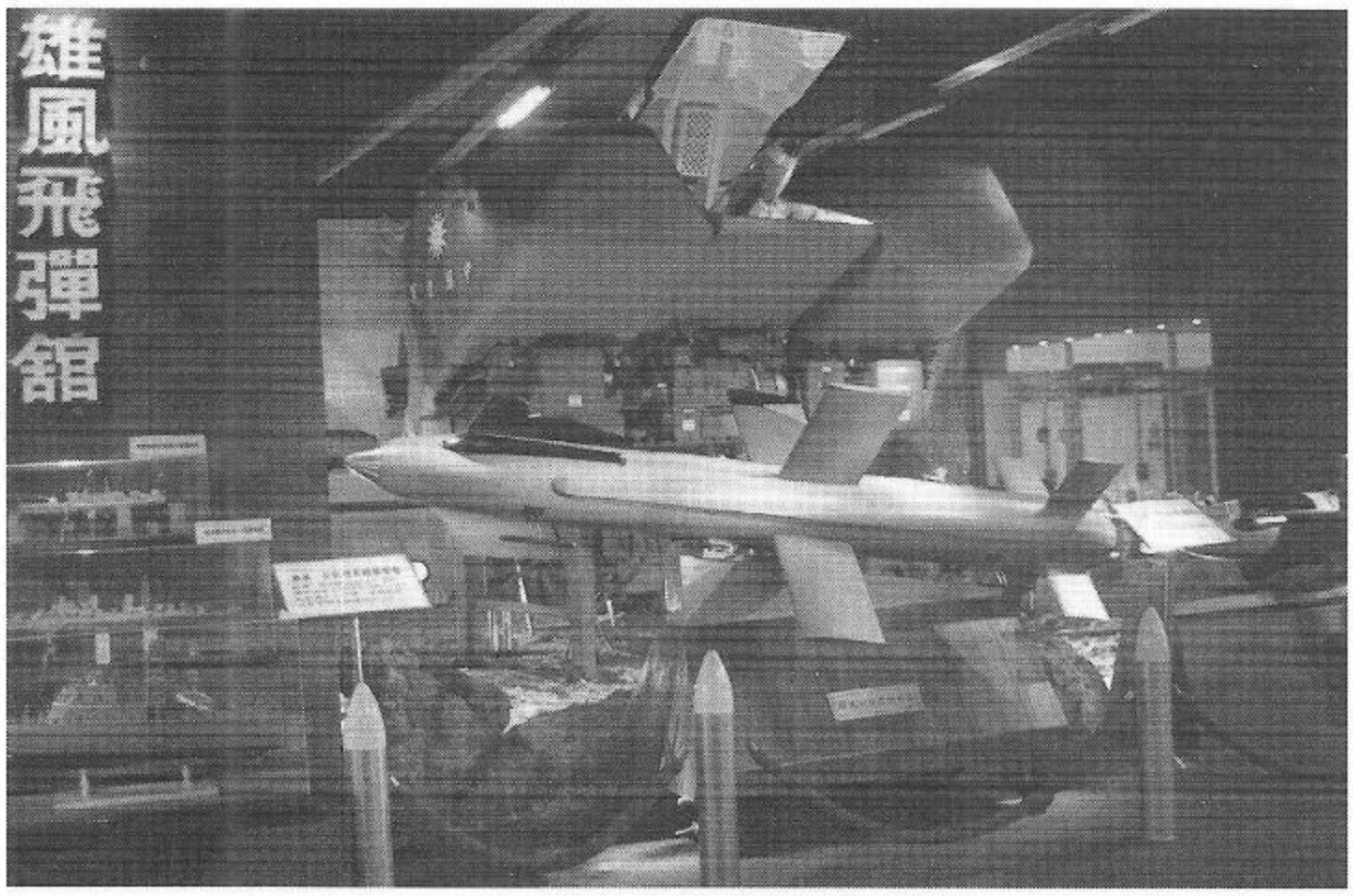
The Mod 1 system has two pairs of fire-control/radar search consoles each controlling a fire-control radar and the gun mountings. One also interfaces with the search radars which share a common antenna, while the other interfaces with the ESM system and the optical director. The two are linked by a databus and the whole system interfaces with an Elbit tactical data handling system.

Mk 37 GFCS

The Mk 37 Gun Fire Control System (GFCS) is used for the 127 mm guns and is a Second World War vintage system, now only to be seen on elderly ex-US Navy destroyers such as this. The director incorporates a 4.6 m (15 ft) stereoscopic rangefinder, a Mk 25 H/I-band radar and a Kollmorgen electro-optical sight. It is reported that in some ships there may also be an IAI Galileo optronic director

Mk 114 Fire Control System

Shuei Yang alone retains its Mk 114 fire-control system for use with its ASROC anti-submarine missiles. The main element is the Mk 53 Attack Console, an electro-mechanical analogue system which consists of two major units, the attack plotter and the ballistic computer. The latter conducts weapon presets for both ASROC and ASW torpedoes. The Mk 114 system also includes the Mk 33 underwater fire-control switchboard which accepts data from two Mk 19 gyrocompasses and other sensors, as well as from the Mk 134 sonar stabilisation computer. The consoles have an AN/UYK-44 reconfigurable processor with some 70,000 lines of CMS-2 language code. The system interfaces with the sonar, in this case the bow-mounted Sangamo SQS-23D.



Hsiung Feng I anti-ship missile, with launcher behind. Range is approximately 19 n miles (36 km)

Manufacturer/Contractor

Loral Librascope, USA.

RADARS

Set	SPS-40 *(Fu Yang, Shuei Yang)*	SPS-29 *(Nan Yang)*	SPS-10 *(Fu Yang, Shuei Yang)*	SPS-58 *(Nan Yang)*	two HR 76 (all)	Mk 25 (Mk 37 GFCS) (all)
Company	Lockheed	Westinghouse	Raytheon/Sylvania	Westinghouse	RCA	Western Electric
Role	Air search	Air search	Surface search	Short-range air search	Fire control	Fire control
Band	E/F	A/B	G	D/E	I/J	I/J
Range	175 n miles (320 km)	250 n miles (457 km)	–	–		91,000 m (100,000 yd)
Beam	1.5 × 16°	19 × 25.5°	1.5 × 16°	6 × 12°	2.7°	1.6°
Peak power	500 kW	750 kW	500 kW	12 kW	250 kW	250 kW
Gain	30 dB	18 dB	30 dB	26 dB	32 dB	39 dB
Pulsewidth	0.25/1.3 µs	10 µs	0.25/1.3 µs	5 µs	0.25/0.5/1 µs	0.25 µs
PRF	650 pps	300 pps	650 pps	2,290/3,300 pps	1,000-3,000 pps	1,320 pps
Scan rate	15 rpm	7.5/15 rpm	15 rpm	20 rpm	–	–

SONARS

STN Atlas Elektronik DSQS-21CZ hull-mounted and variable depth sonar systems

DSQS-21CZ Is installed in *Fu Yang* only. It has a 1 m diameter hull-mounted, medium-frequency transducer array, with 32 preformed beams. It uses computer-aided detection techniques for classification and tracking and the information is presented on colour CRT displays to permit Doppler coding and the discrimination of data on the integrated displays. The sonar system can automatically transmit up to 10 targets directly into SATIR.

(Note: The 'Z' in the designation indicates a variant equipped with electronic stabilisation to minimise the effects of ship's motion)

Manufacturer/Contractor

STN Atlas Elektronik GmbH, Bremen, Germany.

Sangamo AN/SQS 23H

SQS-23H is installed in *Shuei Yang* and *Nan Yang* only. It is a hull-mounted, active search and attack sonar, but operated at low frequency, and is the sonar designed to operate with the ASROC system. The array is cylindrical and has 48 staves, each with two transducers.

Specifications

Frequency: 4.5/5/5.5 kHz
Pulse length: 5/30/50 ms
Nominal range: 14,000 m (15,000 yd)

AVIATION

AVIATION FACILITIES

Specifications

Flight deck (*Shuei Yang, Nan Yang* only): 15 × 10 m (50 × 33 ft)
Hangar: The former DASH hangar is now used by a McDonnell Douglas MD 500 helicopter.

HELICOPTERS

One McDonnell Douglas MD 500.

Specifications

Dimensions
Main rotor diameter: 8.03 m 26.33 ft)
Tail rotor diameter: 1.30 m (4.25 ft)
Fuselage length (rotors turning): 9.24 m (30.31 ft)
Height to top of rotor: 2.48 m (8.14 ft)
Weights
empty: 493 kg (1,088 lb)
max take-off: 1,361 kg (3,000 lb)
Performance
max level speed 305 m (1,000 ft): 132 kts (244 km/h)
economical cruise: 117 kts (217 km/h)
service ceiling: 4,390 m (14,400 ft)
range: 267 n miles (606 km)
max rate of climb: 384 m (1,260 ft)/min
hovering ceiling in ground effect: 2,500 m (8,200 ft)
Power plant: 1 Allison 250-C18A turboshaft derated to 207 kW (278 shp) for take-off
Crew: 2, pilot, co-pilot
Sensors: search radar, Texas Instruments MAD
Typical weapons loads: 1 Mk 46 torpedo or depth bomb

Sea Chaparral launcher with four Sidewinder missiles in place

PROPULSION

Specifications
System: Steam turbines
Main machinery: 4 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 General Electric turbines; 45 MW (60,000 hp);
Shafts: 2

FURTHER INFORMATION

MODERNISATION

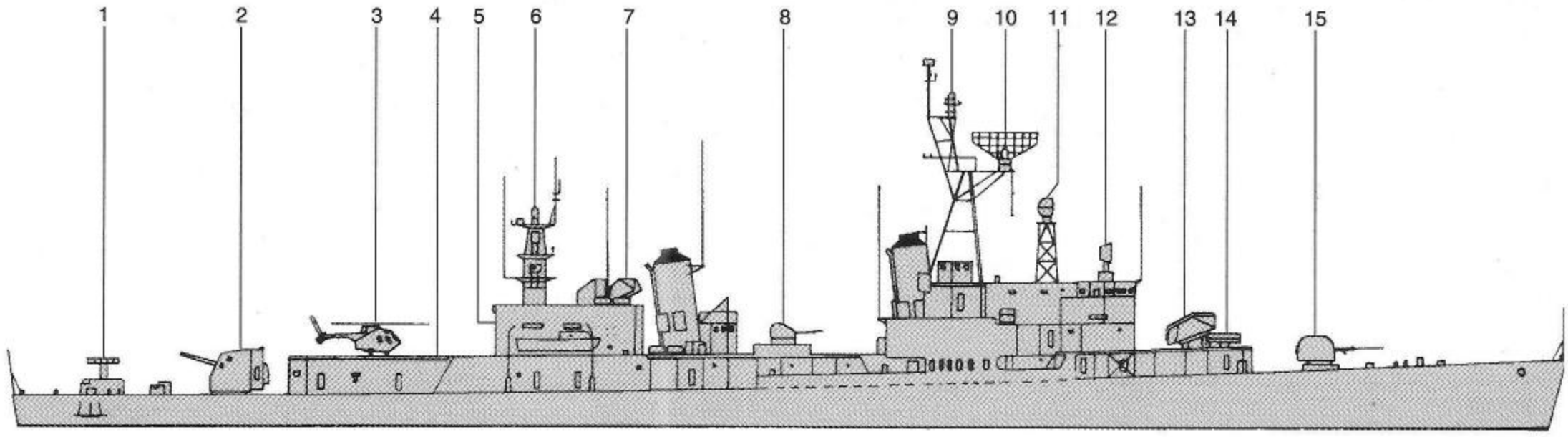
The Wu Chin I modernisation was applied to three ships. The work involved installing five Hsiung Feng SSMs and the Honeywell H 930 Mod 1 fire-control system. Two substantial lattice masts replace the previous pole masts, with the foremast carrying the AN/SPS-29 antenna on a platform and the HR-76 fire director at the head. The mainmast is shorter and carries the second HR-76 at the mast head.

Each ship also received an OTOBREDA 76 mm gun, two Bofors 40 mm/70 single mounts and, a quad Sea Chaparral SAM launcher.

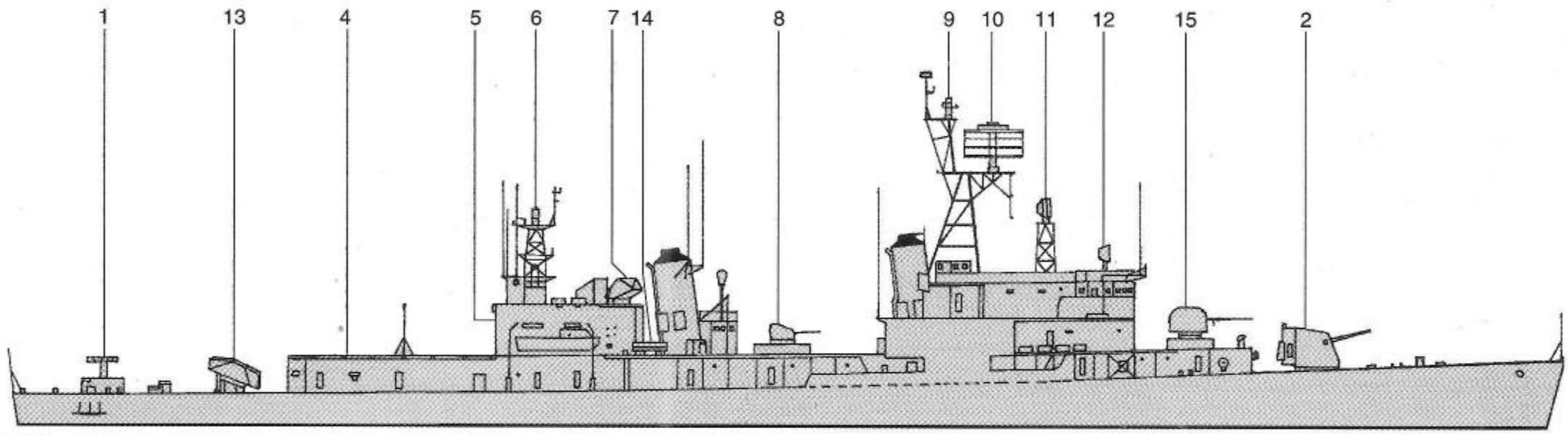
OPERATIONAL

Fu Yang is the Fleet Flagship. *Shuei Yang* is reported to be in poor condition with engine problems and the RoCN is reported to complain that operating old ships and equipment results in heavy maintenance loads.

WU CHIN II



Dang Yang (Ian Sturton)



Kai Yang (Ian Sturton)

1 *Sea Chaparral launcher (Sidewinder missiles (four)* **2** *127 mm (5 in)/38 Mk 38 twin mounting* **3** *McDonnell Douglas MD 500 helicopter* **4** *Flight deck* **5** *Hangar* **6** *Chang Feng II ESM/ECM system* **7** *Single Hsiung Feng II launcher* **8** *Bofors 40 mm cannon* **9** *Elta 1040 radar director* **10** *SPS-40 radar (air search)* **11** *RTN-10X radar (fire control)* **12** *Mk 37 GFCS with Kollmorgen electro-optical sight* **13** *Triple Hsiung Feng II SSM launcher* **14** *Triple Mk 32 324 mm torpedo launcher* **15** *OTOBREDA 76mm (3 in)/.62 Compact*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Republic of China (Taiwan)
Type: US Gearing

Class: WU CHIN II

Active: 4

Displacement:
standard: 2,425 t
full load: 3,500 t (approx)

Dimensions
Length: 119 m (390.5 ft)
Beam: 12.6 m (41.2 ft)

Draught: 5.8 m (19 ft)

Speed: 32.5 kts
Range: 5,800 n miles at 15 kts

Complement: 275 approx

SHIPS

DANG YANG (911)

Builder	Bethlehem Steel, San Francisco, California, USA
Laid down	26 Mar 1944
Launched	5 Oct 1945
Commissioned (US Navy)	21 Mar 1947 (*Lloyd Thomas* (DD 764)) (FRAM II)
Sold to Taiwan	12 Oct 1972

HAN YANG (915)

Builder	Bath Iron Works, Bath, Maine, USA
Laid down	30 Oct 1944
Launched	25 Mar 1945
Commissioned (US Navy)	29 May 1945 (*Herbert J Thomas* (DD 833))
Sold to Taiwan	6 May 1974

LAI YANG (920)

Builder	Bethlehem Steel, San Francisco, California, USA
Laid down	8 June 1945
Launched	4 Jan 1946
Commissioned (US Navy)	28 Jun 1946 (*Leonard F Mason* (DD 852))
Sold to Taiwan	20 Apr 1973

KAI YANG (924)

Builder	Todd Pacific SY, Seattle, Washington, USA
Laid down	1 Dec 1944
Launched	7 Jul 1945
Commissioned (US Navy)	26 Oct 1945 (*Richard B Anderson* (DD 786))
Sold to Taiwan	10 Jun 1977

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

Hsiung Feng II short/medium-range anti-ship missile

There are one triple and two single launchers for Hsiung Feng II anti-ship missiles. Hsiung Feng II is a short-range anti-ship missile, derived from the Israeli Gabriel, powered by a turbojet cruise engine, with rocket boosters for take-off. The fire-control system is similar to that used in Gabriel with a radar tracker (usually HR 76), a display control and processing unit, a vertical reference unit and an optical sight which is usually the Kollmorgen Mk 35 or Model 985. The launcher-containers are also identical to those used in Gabriel and are generally similar to the Harpoon's Mk 141.

The launcher operation is likely to follow that of most conventional medium-range anti-ship missiles with the target acquired by long-range surface search radars with over-the-horizon targeting facilities through a Ta

Chen datalink. The launcher and target locations are inserted into the inertial guidance system, the missile is launched and adopts a low-level cruising altitude. The target is acquired by both the radar and the IR sensors and the returns are compared with an onboard library. If significant deviations in one sensor's returns occur then the guidance system assumes it is being jammed and gives priority to the other as the missile enters the sea-skimming terminal phase.

Specifications
(Hsiung Feng II)
Length: 3.9 m (12.8 ft)
Diameter: 34 cm (13.38 in)
Wing span: 1.35 m (4.43 ft)
Weight: 540 kg (1,190 lb)
Speed: Mach 0.85
Range: 32 n miles (60 km)
Guidance: Semi-active radar, manual or IR homing
Warhead: 150 kg HE (330 lb)
Engine: Microturbo TRI-60 single spool turbojet

SURFACE-TO-AIR MISSILES (SAM)

Loral RIM-72C Sea Chaparral
The Sea Chaparral launcher is sited on the quarterdeck. The Chaparral system was originally developed for the US Army and consists of a manned Mk 54 mounting with two rails on each side, each of which carries a single Sidewinder SAM. In addition to the four missiles on the mounting there are 16 reloads in a magazine. The rails elevate from −9 to +90°.

The Sidewinder missile has an all-aspect-IR seeker, a blast fragmentation warhead, and is powered by a single-stage, solid propellant rocket motor.

The operator sits in an air conditioned cab with controls for activating the system, selecting the missile and initiating the launch sequence. Early warning of the target is provided by the ship's radar and the CIC directs the operator to which direction he should turn the mounting. He acquires the target optically, tracks it and selects and activates a missile for the engagement. When the missile's IR detector has acquired the target, an audio tone sounds and the operator launches the missile. Proportional navigation guidance commands are generated from seeker tracking rates and used to control the missile's flight path.

Sea Chaparral is only in service with the RoCN.

Specifications
Length: 2.91 m (9.54 ft)
Diameter: 12.7 cm (5 in)
Wing span: 63 cm (24.8 in)
Weight: 86.2 kg (190 lb)
Speed: Mach 1.2
Range: 4.75 n miles (9 km)
Guidance: Optical aiming, infrared homing
Warhead: Picatinny Arsenal M-250 12.6 kg HE blast-fragmentation
Motor: Hercules/Atlantic Research Corporation M-121 single-stage, solid propellant rocket motor

Manufacturer/Contractor
Loral, Aeronutronic.

TUBES

Two triple 324 mm US Mk 32 torpedo tubes are sited forward of the bridge *(Dang Yang)* or abreast the after stack (the remainder).

Specifications
Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

Alliant Techsystems 46 Mod 5 324 mm torpedoes

Specifications
Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507.0 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: Liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

GUNS

There is a variation within this group in that all have the same armament of one 127 mm twin turret, one 76 mm Compact turret and a triple Hsiung Feng launcher, but they are laid out in different ways:

Han Yang, Kai Yang and *Lai Yang* have one twin 127 mm (5 in) Mk 38 mounting in 'A' position, a single OTOBREDA 76 mm Compact in 'B' position and a triple Hsiung Feng launcher in 'D' position.

Dang Yang has an OTOBREDA 76 mm Compact in 'A' position, a triple Hsiung Feng launcher in 'B' position and a twin 127 mm (5 in) Mk 38 mounting in 'D' position.

Mk 38 127 mm (5 in) L/38 gun mounting
Han Yang, Kai Yang, and *Lai Yang* have one twin Mk 38 mounting on the foredeck in 'A' position, but only *Dang Yang* also has a second mounting on the afterdeck in 'D' position. The Mk 38 mountings use two Mk 12 guns, with shells being loaded manually into a hydraulically powered ramming tray. The mounting is worked in manual, local or remote control. With automatic control it is operated by a remote fire-control system by means of indicator regulators on the single training gear assembly and the single elevating assembly. Each gun has its own projectile and propellant hoists, with the projectile hoist lift pawls also acting as fuze setters. The mounting requires 13 men within the armoured shield and 14 in the magazines. The approximate life of each barrel is 4,600 EFC (Equivalent Full Charges).

Specifications
Calibre: 127 mm (5 in)
Length of barrel: 38 calibres
Muzzle velocity: 792 m/s (new gun), 762 m/s (mid-life) (2,600/2,500 ft/s)
Range: 13.5 n miles (25.26 km)
Altitude: 12,836 m (42,000 ft)
Weight of shell: 24.95 kg (55 lb)
Traverse: ±164°
Elevation: −15 to +85°
Traverse rate: 25°/s
Elevation rate: 15°/s
Rate of fire: 36 rds/min

OTOBREDA 76 mm (3 in)/62 Compact
All ships have a single OTOBREDA 76 mm (3 in)/62 calibre Compact mounting. This is in 'A' position in *Dang Yang* and in 'B' position in the other three.

Specifications
Elevation: −15 to +85°
Training speed: 70°/s
Elevation speed: 40°/s
Weight (unloaded): 12 t
Muzzle velocity: 900 m/s (2,953 ft/s)
Rate of fire: 85 rds/min
Range: 8.5 n miles (15.75 km)
Weight of shell: 6 kg (13.23 lb)

Bofors 40 mm/70
All have one twin Bofors 40 mm mounting in the gap between the two stacks.

Specifications
Traverse: 360° (nominal) at 90°/s
Elevation: −3 to +85° at 60°/s
Rate of fire: 300 rds/min
Muzzle velocity: 1,005-1,025 m/s (3,297-3,363 ft/s)
Max range:
anti-surface: 6.5 n miles (12 km)
anti-air: 2.2 n miles (4,000 m)
Ammunition weight: 2.4 kg (5.29 lb)
Projectile weight: 0.96 kg (2.11 lb)
Crew: 4

M2HB 12.7 mm (0.50 in) machine guns
All ships carry either four or six M2HB 12.7 mm machine guns, which can be mounted on the ship's rails on flexible mounts.

Specifications
Calibre: 12.7 mm (0.50 in)
Rate of fire: 450-550 rds/min
Muzzle velocity: 883 m/s (2,900 ft/s)
Max effective range:
anti-surface: 6,700 m (7,400 yd)
anti-air: 1,380 m (4,500 ft)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

Chang Feng III ESM/ECM suite
The RoCN's Chang Feng III EW suite is based on the US Navy's AN/SLQ-17 and provides the appropriate threat detection and jamming techniques to counter threats. The Taiwanese system is based on the Hughes MEWS (Modular EW System), which was, in turn, derived from the same company's AN/SLQ-31. The system is intended to protect ships against cruise missiles and other intruders by generating an electronic 'image' of the target ship as it is sensed by the enemy's guidance radar and then offsetting that image so that the incoming missile guides itself to the 'ghost' target which is some distance away.

The system detects and tracks signals of several score missiles of many types, and will track up to several hundred signals from other platforms. It keeps track of signals used for navigation, search, and tracking, and can intercept and track potential missile launch platforms beyond the ranges at which the attacking missiles lock on to the ship. As a signal is received, Chang Feng III automatically measures the radar parameters emitted and the computer searches its memory files to separate friend from foe. If it identifies the signal as hostile, it generates the most effective deception, which will cause the missile to strike the ocean at a safe distance.

Manufacturer/Contractor
Hughes Aircraft Company, Fullerton, California, USA.

DECOYS

CR-201 decoy rocket system
CR-201 is a decoy system with four launchers per ship, two mounted abreast the after stack and two on the quarterdeck. CR-201 is carried by all RoC Navy destroyers and frigates and consists of four launchers, each with sixteen 126 mm (5 in) tubes. There are two types of round: one is for long-range distraction and the other is for short-range break-lock.

T-Mk 6 Fanfare
The T-Mk 6 torpedo decoy consists of two winches each with a cable and a 'fish' containing a mechanical acoustic device. It was introduced into the US Navy in the 1950s and was replaced in most ships by AN/SLQ-25 Nixie.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

Elbit AIO tactical data handling systems

The Elbit Action Information Organisation (AIO) was exported to Taiwan for the Wu Chin II upgrading programme. AIO is designed to accelerate the decision making process by providing data on potential targets, friendly forces, and weapon system status using inputs from shipborne sensors and those of friendly forces and is reported to be capable of tracking up to 12 targets simultaneously and attacking three with a 20 second response time. System highlights include extracting and updating target data, track-while-scan operation, the ability to process two radars simultaneously with real-time handling of up to 50 air and surface targets. It also processes and displays navigation data, exchanges messages with shore-based headquarters and records tactical data for future debriefing.

The system features distributed architecture with two Elta EL/S-9000 computers for system support (one is redundant). The EL/S-9000 is based on the Motorola 68040 microprocessor and Ada software language is used, according to the 2167A development standard. They are linked to workstations by the Tadiran Shipboard Databus (SDB-2) local area network which uses Ethernet (10 Mb/s) or RS-232C (19.2 Kb/s) or RS-449 (38.4 Kb/s) interfaces, and a number of parallel databuses. They are linked through Bus Interface Nodes (BIN) consisting of a VME-based processor (Motorola 68020).

The AIO system was developed jointly by IAI, Israel and the Chung-Shan Institute in Taiwan.

Manufacturer/Contractor
Elbit Computers Ltd, Haifa, Israel.

The US Mk 38 127 mm (5 in) twin mount provides these ships with heavy firepower in engagements involving ranges below 13.5 n miles (25 km)

COMMUNICATIONS AND DATALINKS

Satcom in some
Tacan: SRN 15
Datalink.

WEAPONS CONTROL

H-930 Mod 1 command and weapon control system

The H-930 command and weapon control system is designed to interface with guns and missiles and has a federated architecture based upon Rolm AN/UYK-19 Model 1664 mini-computers which are housed in the display consoles and linked by a databus. The system uses the Algol language software and 30,000 lines of code. The sensor combinations associated with Mod 1 are as follows:

air search radar; AN/SPS-58
surface search radar: AN/SPS-10
fire-control radar: HR-76

The Mod 1 system has two pairs of fire-control/radar search consoles each controlling a fire-control radar and the gun mountings. One also interfaces with the search radars, which share a common antenna, while the other interfaces with the ESM system and the optical director. The two are linked by a databus and the whole system interfaces with an Elbit tactical data handling system.

Mk 37 GFCS

The Mk 37 Gun Fire Control System (GFCS) is used for the 127 mm guns and is a Second World War vintage system, now only to be seen on elderly ex-US Navy destroyers such as this. The director incorporates a 4.6 m (15 ft) stereoscopic rangefinder, a Mk 25 H/I-band radar and a Kollmorgen electro-optical sight. It is reported that in some ships there may also be an IAI Galileo optronic director

RADARS

Set	**SPS-40 *(Dang Yang)***	**SPS-29 (Others)**	**EL/M-2208**	**two HR 76 (all)**	**RTN-10X (SPG-70)**
Company	Lockheed	Westinghouse	Elta	RCA	Selenia
Role	Air search	Air search	Air/surface search	Fire control (guns/missiles)	
Band	E/F	B/C	F	H/I	I/J	I/J
Range	175 n miles (320 km)	250 n miles (457 km)			22 n miles (40 km)
Beam	1.5 × 16°	19 × 25.5°	3 × 10°	1 × 5°	2.7°	
Peak power	500 kW	750 kW	425 kW	25 kW	250 kW	200 kW
Gain	30 dB	18 dB	28 dB	34 dB	32 dB	
Pulsewidth	0.25/1.3 µs	10 µs	1.4/0.4 µs	0.25 µs	0.25/0.5/1 µs	1.5 µs
PRF	650 pps	300 pps	500-750 pps	1,000-1,500 pps	1,000-3,000 pps	450-550 pps
Scan rate	15 rpm	7.5/15 rpm	12/24 rpm	—		

SONARS

STN Atlas Elektronik DSQS-21CZ hull-mounted and variable depth sonar systems

DSQS-21CZ Is installed in *Dang Yang* only. It has a 1 m diameter hull-mounted, medium-frequency transducer array, with 32 preformed beams. It uses computer-aided detection techniques for classification and tracking and the information is presented on colour CRT displays to permit Doppler coding and the discrimination of data on the integrated displays. The sonar system can automatically transmit up to 10 targets directly into SATIR.

(Note: The 'Z' in the designation indicates a variant equipped with electronic stabilisation to minimise the effects of ship's motion)

Manufacturer/Contractor

STN Atlas Elektronik GmbH, Bremen, Germany.

Sangamo SQS 23H

SQS-23H is installed in the other Wu Chin II ships. It is a hull-mounted, active search and attack sonar, but operated at low frequency. The array is cylindrical and has 48 staves, each with two transducers.

Specifications

Frequency: 4.5/5/5.5 kHz
Pulse length: 5/30/50 ms
Nominal range: 14,000 m (15,000 yd)

AVIATION

AVIATION FACILITIES

Specifications

Flight deck (*Shuei Yang, Nan Yang* only): 15 × 10 m (50 × 33 ft)
Hangar: The former DASH hangar remains in use

HELICOPTERS

One McDonnell Douglas MD 500

Specifications

Dimensions
Main rotor diameter: 8.03 m (26.33 ft)
Tail rotor diameter: 1.30 m (4.25 ft)
Fuselage length (rotors turning): 9.24 m (30.31 ft)
Height to top of rotor: 2.48 m (8.14 ft)
Weights
empty: 493 kg (1,088 lb)
max take-off: 1,361 kg (3,000 lb)
Performance
max level speed 305 m (1,000 ft): 132 kts (244 km/h)
economical cruise: 117 kts (217 km/h)
service ceiling: 4,390 m (14,400 ft)
range: 267 n miles (606 km)
max rate of climb: 384 m (1,260 ft)/min
hovering ceiling in ground effect: 2,500 m (8,200 ft)
Power plant: 1 Allison 250-C18A turboshaft derated to 207 kW (278 shp) for take-off
Crew: 2, pilot, co-pilot
Sensors: Search radar, Texas Instruments MAD
Typical weapons loads: 1 Mk 46 torpedo or depth bomb

PROPULSION

Specifications

System: Steam turbine
Main machinery: 4 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 General Electric turbines; 45 MW (60,000 hp)
Shafts: 2

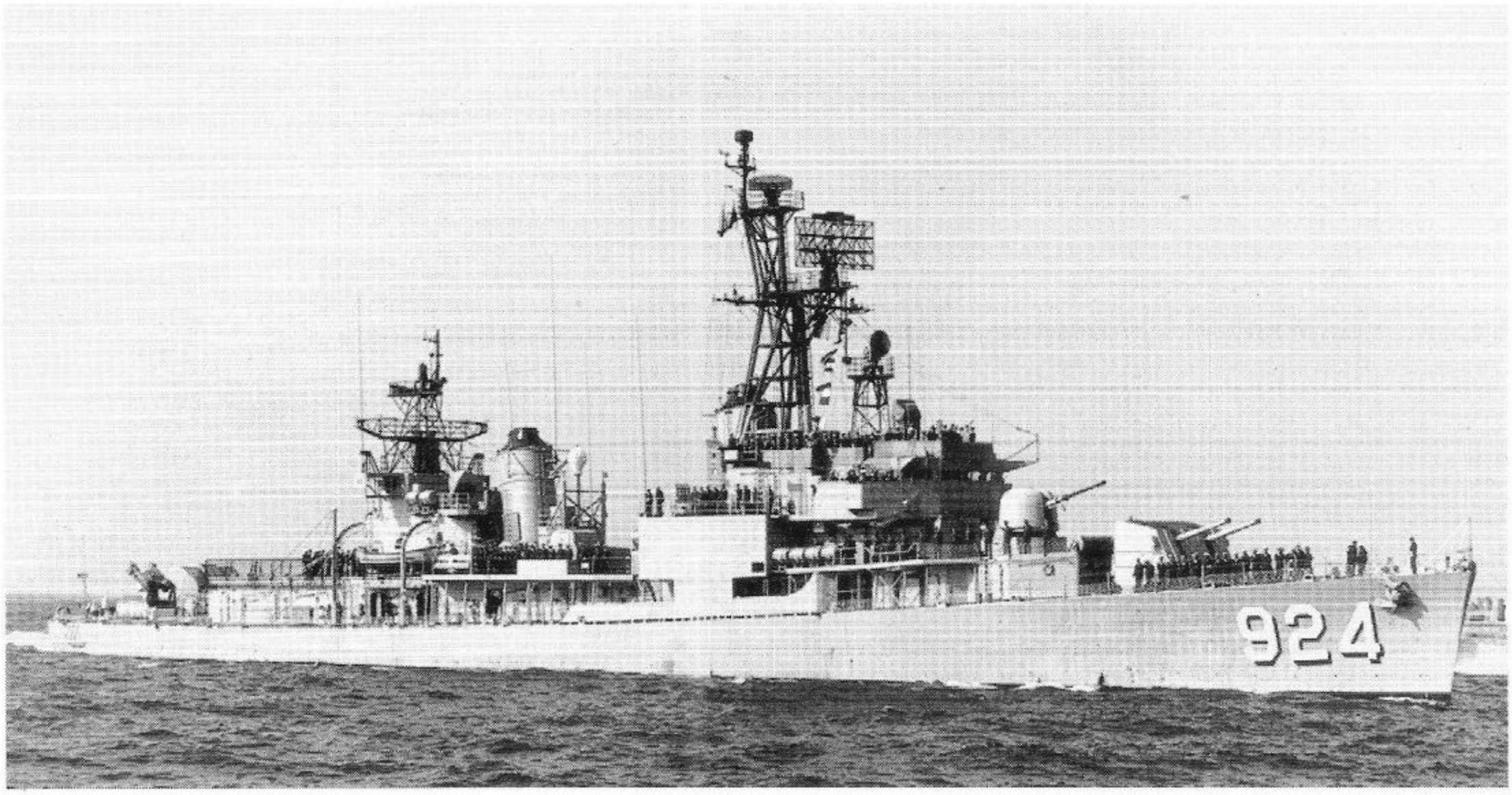
FURTHER INFORMATION

MODERNISATION

The main difference between Wu Chin I and Wu Chin II ships is that the latter have the Elbit AIO digital command system, an Elta EL/M-2208 radar and an RTN-10X fire-control system which enables them to fight in a much more co-ordinated and effective manner. Like Wu Chin I conversions, the Wu Chin II also have an OTOBREDA 76 mm gun, two Bofors 40 mm/70 single mounts, a quad Sea Chaparral SAM launcher and five (two single and one triple) Hsiung Feng I missile launchers. An RTN-10X on a lattice mast and an Officine Galileo optronic director replaced the Mk 37 fire-control director on the bridge.

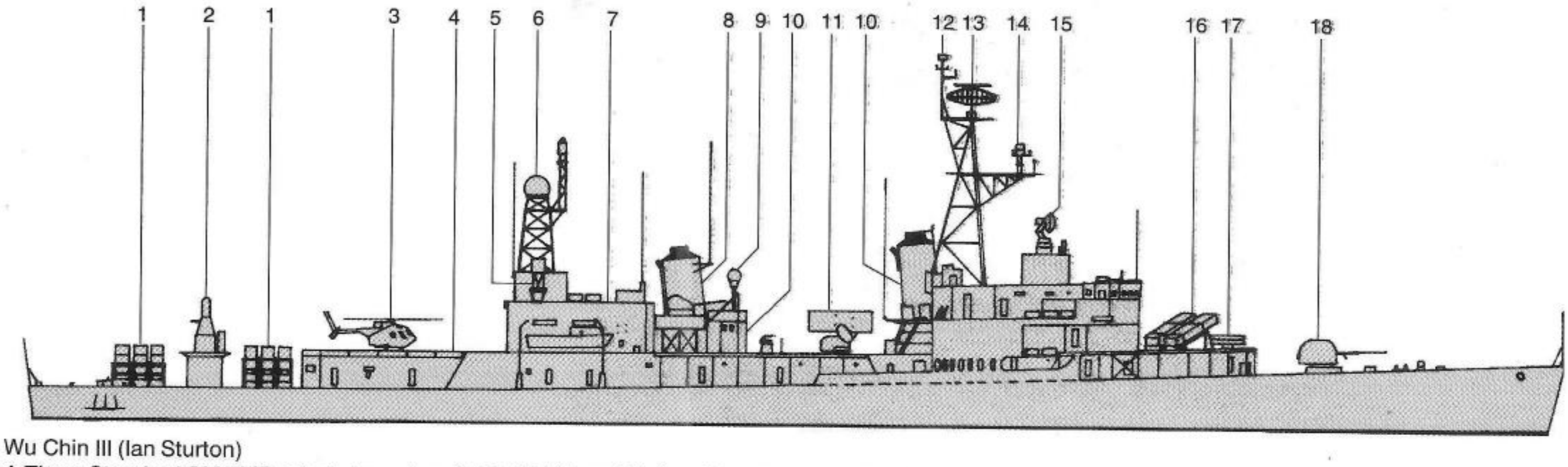
OPERATIONAL

Han Yang is in poor condition with engine problems.



Kai Yang *(924). Apart from the unusual weapons arrangement the Wu Chin II can be identified by the tripod on the bridge roof, supporting the Selenia (now Alenia) RTN-10X fire-control radar* (H & L van Ginderen Collection)

WU CHIN III



Wu Chin III (Ian Sturton)
1 *Three Standard SM-1MR missle launchers* **2** *Mk 15 Vulcan Phalanx 20 mm CIWS* **3** *McDonnell Douglas MD-500 helicopter* **4** *Flight deck* **5** *Chang Feng III jammers* **6** *W-160 radar director (for Bofors 40 mm)* **7** *Hangar* **8** *Bofors 40 mm mount (at after end of hangar in some other ships)* **9** *Satcom antenna* **10** *Kung Fen 6 16-tubed chaff launchers* **11** *Mk 112 ASROC launcher* **12** *SRN-15 TACAN* **13** *Signaal DA-08 (with DA-05 antenna) (air search)* **14** *SPS-10/-58 radar (surface search)* **15** *Signaal STIR fire control (Standard and 76 mm gun)* **16** *Twin Standard SM-1MR launchers (two sets)* **17** *Triple 324 mm Mk 32 torpedo tubes (two sets)* **18** *76 mm (3 in) Compact gun mounting*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Republic of China (Taiwan)

Class: WU CHIN III

Converted: 7

Active: 7

Displacement:
standard: 2,425 t
full load: 3,500 t (approx)

Dimensions
Length: 119 (390.5 ft)
Beam: 12.6 (41.2 ft)
Draught: 5.8 m (19 ft)

Speed: 32.5 kts
Range: 5,800 n miles at 15 kts

Complement: 275 approx

SHIPS

CHIEN YANG (912)

Builder	Todd Pacific SY, Seattle, Washington, USA
Laid down	27 Dec 1944
Launched	4 Aug 1945
Commissioned (US Navy)	8 Feb 1946 (*James E Kyes* (DD 787))
Sold to Taiwan	18 Apr 1973

LIAO YANG (921)

Builder	Bath Iron Works, Bath, Maine, USA
Laid down	7 Oct 1944
Launched	11 Mar 1945
Commissioned (US Navy)	11 May 1945 (*Hanson* (DD 832))
Sold to Taiwan	18 April 1973

SHEN YANG (923)

Builder	Todd Pacific SY, Seattle, Washington, USA
Laid down	18 Jan 1945
Launched	9 Oct 1945
Commissioned (US Navy)	26 Mar 1946 (*Hollister* (DD 788))
Sold to Taiwan	1 Oct 1977

TE YANG (925)

Builder	Bath Iron Works, Bath, Maine, USA
Laid down	15 Jan 1945
Launched	27 May 1945
Commissioned (US Navy)	31 Jul 1945 (*Sarsfield* (DD 837))
Sold to Taiwan	1 Oct 1977

YUN YANG (927)

Builder	Consolidated Steel Corporation, Orange, Texas, USA
Laid down	6 May 1945
Launched	19 Oct 1945
Commissioned (US Navy)	10 Oct 1946 (*Johnston* (DD 821))
Sold to Taiwan	December 1980

CHEN YANG (928)

Builder	Bath Iron Works, Bath, Maine, USA
Laid down	26 Feb 1945
Launched	30 Jun 1945
Commissioned (US Navy)	13 Sep 1945 (*Power* (DD 839))
Sold to Taiwan	27 Feb 1981

SHAO YANG (929)

Builder	Federal SB and DD Co, Kearny, USA
Laid down	5 Apr 1945
Launched	24 Nov 1945
Commissioned (US Navy)	11 Jul 1946 (*Hamner* (DD 718))
Sold to Taiwan	3 Mar 1983

WEAPONS SYSTEMS

SURFACE-TO-SURFACE/SURFACE-TO-AIR MISSILES (SSM/SAM)

Standard Missile-1 Medium Range (SM-1MR)

Main air defence weapons are 10 SM-1MRs which are launched from a launcher-container unique to the RoC Navy. These are single missile launchers at a fixed elevation, which are in two groups of three and two groups of two. The two triple groups are on the afterdeck separated by the Vulcan Phalanx CIWS: the forward group points to port, the after group to starboard. The two pairs are before the bridge in the 'B' gun position, pointing to the opposite beam at an angle of about 45°. There are no reloads.

The missiles have both surface-to-air and surface-to-surface roles and are controlled by the H-930 weapon control system and the STIR fire-control radar. Once a potential target has been detected, the data is evaluated and the target is designated for the missile fire-control system, which then tracks and illuminates it. Once the missile is launched, the tracker's main illumination beam holds the target while the rear reference illuminator beam provides guidance data through the missile's rear reference antenna. This guides the missile until the onboard seeker detects the CW reflected energy from the main illuminator beam, at which point the missile's onboard guidance system brings the missile to an interception course.

Specifications
Length: 4.48 m
Diameter: 34.3 cm
Wing span: 1.06 m
Weight: 642.3 kg
Speed: Mach 2
Range: 25 n miles (46 km)
Height envelope: 50-18,000 m (150-60,000 ft)

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA.
Raytheon, Missile Systems Division, Bedford, Maryland, USA.

ANTI-SUBMARINE MISSILES

Loral RUR-5A ASROC

Unlike the Wu Chin I (except for *Shuei Yang*) and Wu Chin II conversions, the Wu Chin IIIs retain their Mk 112 ASROC launchers, which are located in the gap between the stacks with a magazine immediately

beneath it. ASROC consists of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target including submarines with anechoically coated hulls and has an estimated acquisition range of 460 m.

When the ship sensors detect a submarine target it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m, although the aerodynamically stable airframe enables it to coast up to 600 m. On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and, as they separate, the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications

ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg; PBXN-103

Manufacturer/Contractor

Honeywell Training and Control Systems, West Covina, California.

TUBES

Two triple 324 mm US Mk 32 torpedo tubes are sited forward of the bridge *(Dang Yang)* or abreast the after stack (the remainder).

Specifications

Length: 3.43 m (11.25 ft)
Height: 1.26 m (4.13 ft)
Width: 94.3 cm (3.09 ft)
Tubes: 3
Tube diameter: 324 mm (12.75 in)

TORPEDOES

Alliant Techsystems 46 Mod 5 324 mm torpedoes

Specifications

Length: 2.59 m (8.50 ft)
Diameter: 324 mm (12.75 in)
Weight: 230 kg (507.0 lb)
Warhead: 44 kg (97 lb) HE
Propulsion: liquid propellant
Speed: 45 kts
Range: 5 n miles (9.25 km)
Acquisition range: 460 m (1,510 ft) (estimated)

GUNS

FMC/OTOBREDA 76 mm (3 in)/62 Mk 75 Compact

There is one OTOBREDA 76 mm (3 in) gun sited in the 'A' position previously occupied by a twin 127 mm turret.

Specifications

Calibre: 76.2 mm (3.0 in)
Length of barrel: 62 calibres (4.72 m; 15.49 ft)
Traverse: 360° at 70°/s
Elevation: −15 to +85° at 40°/s
Muzzle velocity: 900 m/s (2,953 ft/s)
Max rate of fire: 85 rds/min
Range: 8.6 n miles (16 km)

Manufacturer/Contractor

OTOBREDA, La Spezia, Italy.

Hughes Mk 15 CIWS Phalanx

There is one Hughes Mk 15 Phalanx close in weapons system (CIWS) sited on the quarterdeck. The mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n miles (1.85 km) with a max probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications

Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0) 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse-Doppler

Manufacturer/Contractor

Hughes Missile Systems, Tucson, Arizona, USA (system).

Bofors 40 mm/70

All have two single Bofors 40 mm mountings.

Specifications

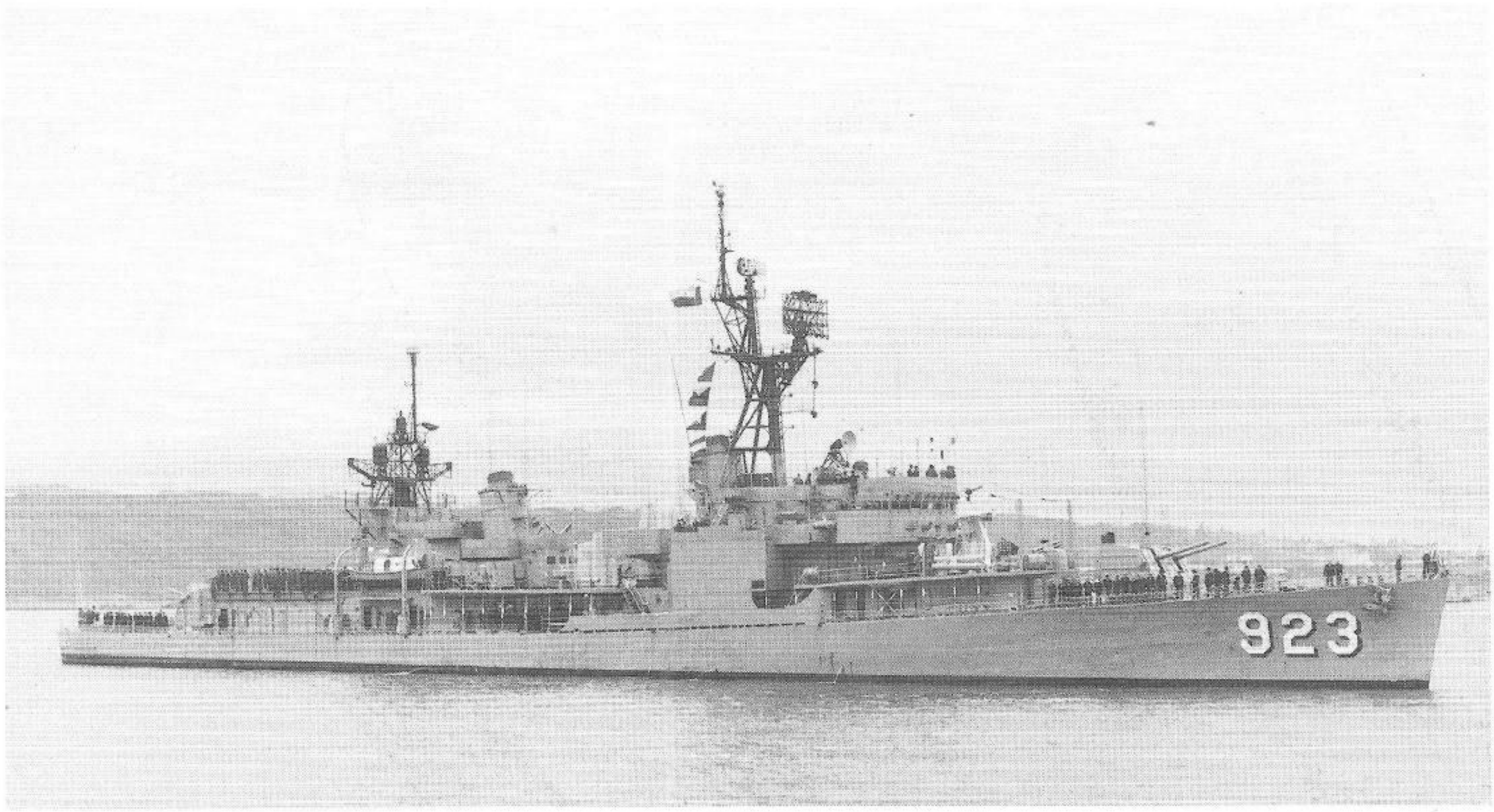
Traverse: 360° (nominal) at 90°/s
Elevation: −3 to +85° at 60°/s
Rate of fire: 300 rds/min
Muzzle velocity: 1,005-1,025 m/s (3,297-3,363 ft/s)
Max range:
anti-surface: 6.5 n miles (12 km)
anti-air: 2.2 n miles (4,000 m)
Ammunition weight: 2.4 kg (5.29 lb)
Projectile weight: 0.96 kg (2.11 lb)
Crew: 4

M2HB 12.7 mm (0.50 in) machine guns

All ships carry either four or six M2HB 12.7 mm machine guns, which can be mounted on the ship's rails on flexible mounts.

Specifications

Calibre: 12.7 mm (0.50 in)
Rate of fire: 450-550 rds/min
Muzzle velocity: 883 m/s (2,900 ft/s)
Max effective range:
anti-surface: 6,700 m (7,400 yd)
anti-air: 1,380 m (4,500 ft)



Shen Yang *(923) prior to its Wu Chin III conversion, with standard FRAM weapons including two twin 127 mm (5 in) mountings in 'A' and 'Y' positions; two sets of triple 324 mm torpedo tubes, a Hedgehog mortar before the bridge; and an eight-cell ASROC launcher* (H & L van Ginderen Collection)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

Chang Feng III ECM suite

The RoCN's Chang Feng III EW suite is based on the US Navy's AN/SLQ-17 and provides the appropriate threat detection and jamming techniques to counter threats. The Taiwanese system is based on the Hughes MEWS (Modular EW System) and was developed jointly by Taiwan's Chung-Shan Institute of Science and Technology (CSIST) and the Hughes company. The Chang Feng III employs phased-array antennas which resemble those of the Hughes SLQ-17 and is capable of both deception and noise jamming. In the deception mode the system protects ships against cruise missiles and other intruders by generating an electronic 'image' of the target ship as it is sensed by the enemy's guidance radar and then offsetting that image so that the incoming missile guides itself to the 'ghost' target which is some distance away.

The system detects and tracks signals of several score missiles of many types, and will track up to several hundred signals from other platforms. It keeps track of signals used for navigation, search, and tracking, and can intercept and track potential missile launch platforms beyond the ranges at which the attacking missiles lock on to the ship. As a signal is received, Chang Feng III automatically measures the radar parameters emitted and the computer searches its memory files to separate friend from foe. If it identifies the signal as hostile, it generates the most effective deception, which will cause the missile to strike the ocean at a safe distance.

Manufacturer/Contractor

Hughes Aircraft Company, Fullerton, California, USA.

DECOYS

CR-201 decoy rocket system

CR-201 is a decoy system with four launchers per ship, two mounted abreast the after stack and two on the quarterdeck. CR-201 is carried by all RoC Navy destroyers and frigates and consists of four launchers, each with sixteen 126 mm (5 in) tubes. There are two types of round: one is for long-range distraction and the other is for short-range break-lock.

T-Mk 6 Fanfare

The T-Mk 6 torpedo decoy consists of two winches each with a cable and a 'fish' containing a mechanical acoustic device. It was introduced into the US Navy in the 1950s and was replaced in most ships by AN/SLQ-25 Nixie.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS AND DATALINKS

Ta Chen tactical datalink.
Tacan: SRN 15

WEAPONS CONTROL

H-930 Mod 1 command and weapon control system

The H-930 command and weapon control system is designed to interface with guns and missiles and has a federated architecture based upon Rolm AN/UYK-19 Model 1664 mini-computers which are housed in the display consoles and linked by a databus. The system uses the Algol language software and 30,000 lines of code. The sensor combinations associated with Mod 1 are as follows:

air search radar; AN/SPS-58
surface search radar: AN/SPS-10
fire-control radar: HR

The Mod 1 system has two pairs of fire-control/radar search consoles each controlling a fire-control radar and the gun mountings. One also interfaces with the search radars which share a common antenna, while the other interfaces with the ESM system and the optical director. The two are linked by a databus and the whole system interfaces with an Elbit tactical data handling system.

Loral Mk 114 Fire-Control System

The Mk 114 is the fire-control system for ASW operations and is interfaced with the HR-930 via an analogue/digital converter. The main element is the Mk 53 Attack Console, an electromechanical analogue system which consists of two major units, the attack plotter and the ballistic computer. The latter conducts weapon presets for both ASROC and ASW torpedoes. The Mk 114 system also includes the Mk 33 underwater fire-control switchboard which accepts data from two Mk 19 gyrocompasses and other sensors, as well as from the Mk 134 sonar stabilisation computer. The consoles have an AN/UYK-44 reconfigurable processor with some 70,000 lines of CMS-2 language code. The system interfaces with the sonar, in this case the bow-mounted Sangamo SQS-23D.

Manufacturer/Contractor

Loral Librascope, USA.

SONARS

Sangamo SQS 23H

SQS-23H is installed in the other Wu Chin II ships. It is a hull-mounted, active search and attack sonar, but operated at low frequency. The array is cylindrical and has 48 staves, each with two transducers.

Specifications

Frequency: 4.5/5/5.5 kHz
Pulse length: 5/30/50 ms
Nominal range: 14,000 m (15,000 yd)

RADARS

Type	DA-08	SPS-10	SPS-58	STIR	W-160
Company	Signaal	Raytheon/Sylvania	Westinghouse	Signaal	Westinghouse
Role	Surface/air search	Surface search	Surface search	Fire control (Standard/ 76 mm gun)	Fire control (Bofors 40 mm)
Band	D/E	G/I	G/I	I/J/K	I
Beam	1.5 × csc² to 40°	1.5 × 16°	6 × 12°	1.4°	2.5°
Peak Power	145 kW	500 kW	12 kW	220 kW	16 kW
Gain	33 dB	30 dB	26 dB	—	36 dB
Pulsewidth	35/69 µs	0.25/1.3 µs	5 µs	0.29 µs	1-10 µs
PRF	1,000/500 pps	650 pps	2,290/3,300 pps	1,800/3,600 pps	8 rates between 1,000 and 14,200 pps
Scan rate	10/20 rpm	15 rpm	20 rpm	—	—
Typical range	78-92 n miles for 2 m² target. Min 0.8 n miles	—	—	76 n miles (140 km)	25 n miles on 1 m² target

PROPULSION

Specifications
System: Steam turbine
Main machinery: 4 Babcock & Wilcox boilers; 43.3 kg/cm² (600 psi); 454°C (850°F); 2 General Electric turbines; 45 MW (60,000 hp)
Shafts: 2

AVIATION

AVIATION FACILITIES

Specifications
Flight deck (*Shuei Yang, Nan Yang* only): 15 × 10 m (50 × 33 ft)
Hangar: The former DASH hangar remains in use

HELICOPTERS

One McDonnell Douglas MD 500

Specifications
Dimensions
Main rotor diameter: 8.03 m (26.33 ft)
Tail rotor diameter: 1.30 m (4.25 ft)
Fuselage length (rotors turning): 9.24 m (30.31 ft)
Height to top of rotor: 2.48 m (8.14 ft)
Weights
empty: 493 kg (1,088 lb)
max take-off: 1,361 kg (3,000 lb)
Performance
max level speed 305 m (1,000 ft): 132 kts (244 km/h)
economical cruise: 117 kts (217 km/h)
service ceiling: 4,390 m (14,400 ft)
range: 267 n miles (606 km)
max rate of climb: 384 m (1,260 ft)/min
hovering ceiling in ground effect: 2,500 m (8,200 ft)
Power plant: 1 Allison 250-C18A turboshaft derated to 207 kW (278 shp) for take-off
Crew: 2, pilot, co-pilot
Sensors: Search radar, Texas Instruments MAD
Typical weapons loads: 1 Mk 46 torpedo or depth bomb

FURTHER INFORMATION

PROGRAMME

The aim of the Wu Chin III programme was to produce a number of area air defence ships, but, as always with the RoC NAVY, this had to be achieved with outdated hulls and whatever weapons and sensors they could obtain in the world markets in the light of open hostility from the PRC. An eighth ship, *Liao Yang,* was to have been given the same conversion but missed the programme after a grounding incident in 1987.

MODERNISATION

The work concentrated on area air defence and involved the installation of the H-930 Modular Combat System (MCS) with a Signaal DA-08 air search radar (employing a lightweight DA-05 antenna) and a Signaal STIR missile control radar. The actual weapons are ten box-launched Standard SM-1MR surface-to-air missiles. The area system can track 24 targets simultaneously and attack four with an eight second response time.

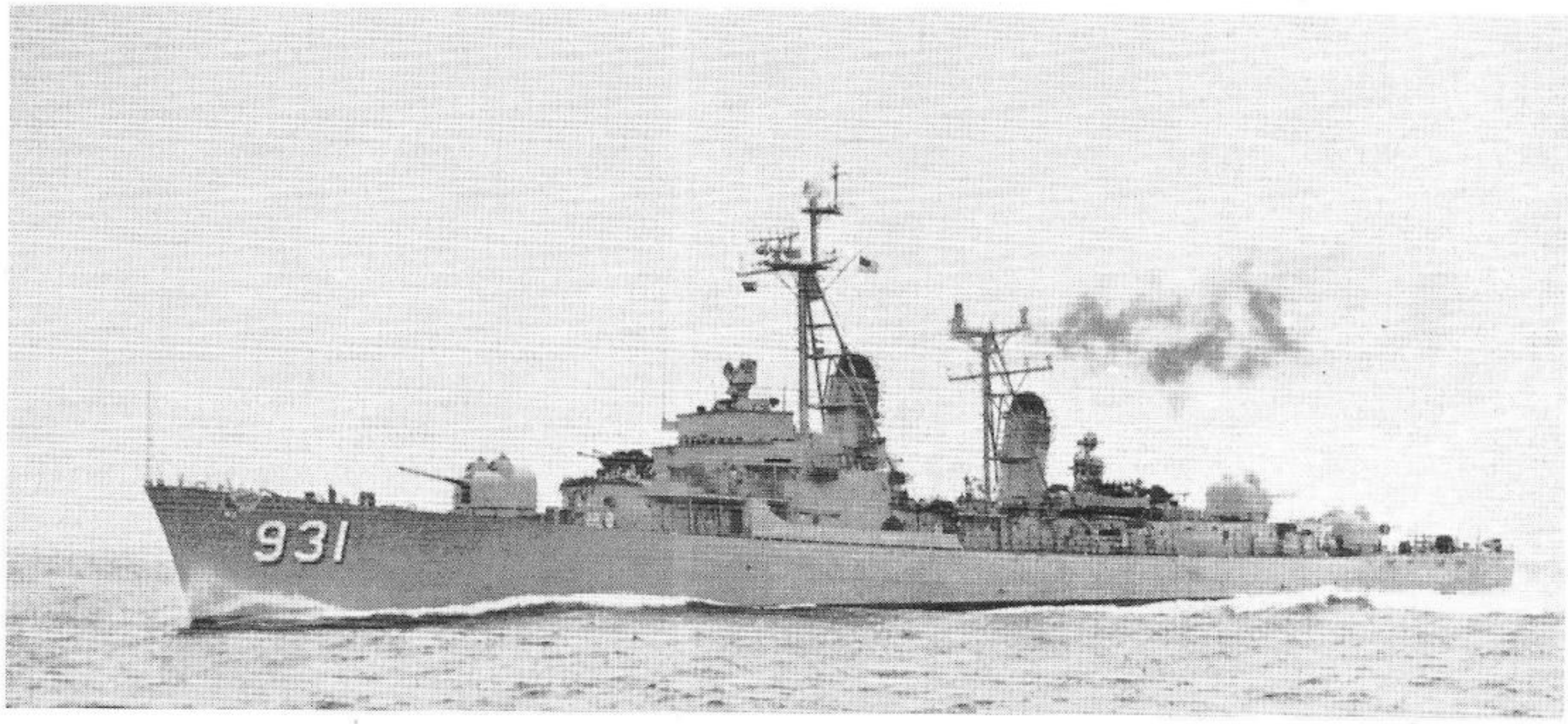
For short-range defence, there are one OTOBREDA 76 mm Compact, two Bofors 40 mm/70s and a Mk 15 Block 1 Phalanx CIWS. A Westinghouse W-160 is mounted on a lattice mast on the hangar to control the Bofors. The amidships ASROC launcher has been retained with its Mk 114 fire-control system integrated with the H-930 MCS via a digital-analogue interface. The AN/SQS-23 sonar has also been upgraded to the H standard using a Raytheon solid-state transmitter.

For EW, the Chang Feng III system was developed jointly by Taiwan's Chung-Shan Institute of Science and Technology (CSIST) and US company, Hughes. The Chang Feng III employs phased-array antennas which resemble those of the Hughes SLQ-17; it is capable of both deception and noise jamming.

Liao Yang *(921) following its Wu Chin III conversion. On the quarterdeck are three launcher-containers for Standard SM-1MR missiles, which in this installation are used in both anti-air and anti-ship roles; the mountings for the other three missiles are between the Vulcan Phalanx CIWS and the flight deck, but the missiles are not fitted. Either side of the hangar is a turret-mounted single 40 mm cannon, while forward of the bridge are four more SM-1MR launchers, two triple 324 mm torpedo tubes and an OTOBREDA 76 mm gun. Thus, virtually all of the original US equipment has been removed except for the ASROC launcher amidships. The football-shaped radome atop the mainmast is the Westinghouse W-160 fire-control radar for the Bofors while the objects at either side of the base of the mast are probably the jammers for the Chang Feng III ESM/ECM suite* (Jane's/IDR)

'CHARLES F ADAMS' CLASS

OVERVIEW

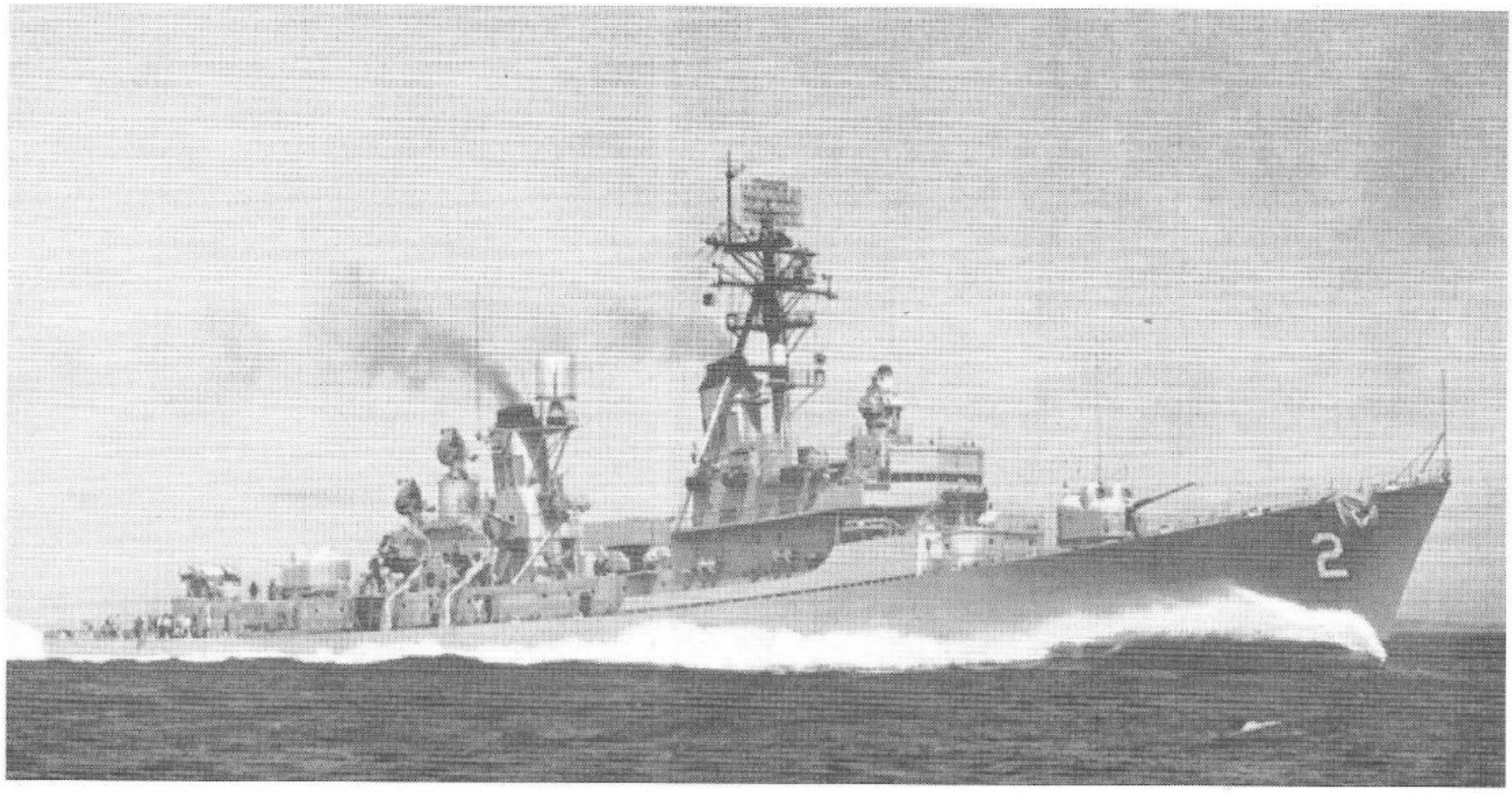


The 'Forrest Sherman' class of 18 destroyers were the only purely gun-armed destroyers to be built for the US Navy after the Second World War, and were armed with three single 127 mm (5 in) guns, two twin 76 mm (3 in) guns in open mounts, two Hedgehogs and four 533 mm (21 in) torpedo tubes (US Navy)

Twenty-nine of these destroyers were built between 1958 and 1970, all in United States yards; 23 were for the US Navy and three each as direct sales to Australia and Germany. They were the first purpose-built guided-missile destroyers (DDG).

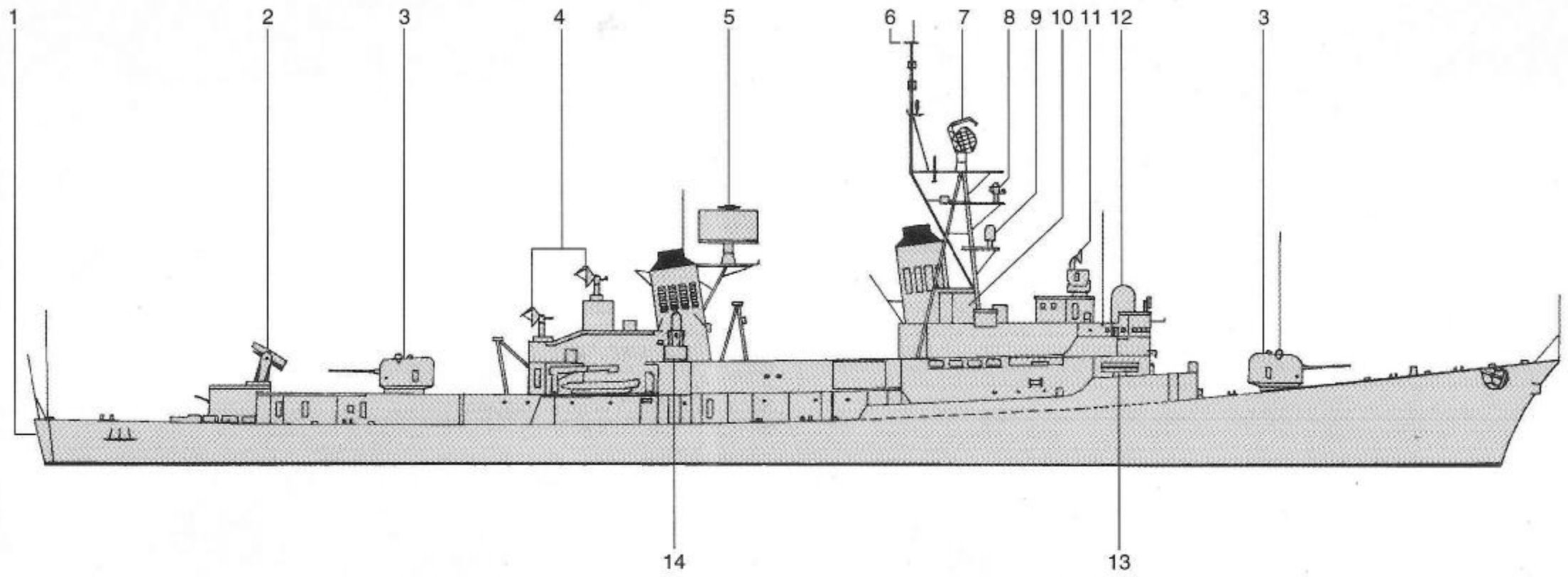
The main weapons system was a single-armed Tartar launcher mounted atop its magazine aft, with two single 127 mm (5 in) guns, one forward in 'A' position, the other aft in 'X' position. An eight-cell ASROC launcher was located between the stacks and there were two triple lightweight torpedo tubes. The hull design was an evolutionary development of the 'Forrest Sherman' type, but with greater length and a wider beam, and with the then fashionable aluminium superstructure to reduce topweight.

The 'Charles F Adams' class was one of the most formidable destroyers of its time and its weapons and sensors were constantly updated during its US Navy service. The 23 US ships were all decommissioned between 1989 and 1992. Of these, three were sold to Greece for active employment, while two were sold as hulks for use as a source of spares; one to Australia the other to Greece.



The 'Charles F Adams' class was originally going to be a straightforward modification of the 'Forrest Sherman' class but, as usual in such circumstances, the outcome was a much larger ship. Charles F Adams *(DDG 2) was armed with two single 127 mm (5 in) guns, a Tartar SAM launcher with 42 missiles aft, an ASROC eight-cell launcher amidships and six Mk 32 324 mm torpedo tubes. It was a very successful design, with 23 built for the US Navy and three each for Australia and Germany* (US Navy)

PERTH (CHARLES F ADAMS)



Modified Charles F Adams (Ian Sturton)
1 *SLQ-25 Nixie towed decoy* **2** *Mk 13 Mod 6 launcher for Standard SAM and Harpoon SSM (latter not currently carried)* **3** *Mk 42 Mod 10 127 mm (5 in)/54 single automatic gun* **4** *Raytheon SPG-51C fire control (Standard missiles)* **5** *Hughes SP5-52C radar (air search)* **6** *AIMS Mk 12 IFF* **7** *Lockheed SP5-40c radar (air search)* **8** *Norden SP5-67(V) radar (surface search)* **9** *WLR-1H radar intercept* **10** *OE-2 Satcom* **11** *Western Electric SPG-53F fire control (guns)* **12** *Satcom* **13** *US Navy triple Mk 32 324 mm torpedo tubes* **14** *Mk 15 Vulcan Phalanx 20 mm CIWS*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Australia
Type: CHARLES F ADAMS

Class: PERTH (Modified CHARLES F ADAMS)

Built: 3
Active: 3

Displacement:
standard: 3,370 t
full load: 4,618 t

Dimensions
Length: 134.3 m (440.8 ft)
Beam: 14.3 m (47.1 ft)
Draught: 6.1 m (20.1 ft)

Speed: 33 kts
Range: 6,000 n miles at 15 kts; 2,000 n miles at 30 kts

Complement: 325 (25 officers)

SHIPS

PERTH (D 38)

Builder	Defoe Shipbuilding Co, Bay City, Michigan, USA
Laid down	21 Sep 1962
Launched	26 Sep 1963
Commissioned	17 Jul 1965
Modernised	1974 (USA)
Modernised	1989 (Australia)

HOBART (D 39)

Builder	Defoe Shipbuilding Co, Bay City, Michigan, USA
Laid down	26 Oct 1962
Launched	9 Jan 1964
Commissioned	18 Dec 1965
Modernised	1978 (Garden Island Dockyard, Sydney, Australia)
Modernised	1991 (Australia)

BRISBANE (D 41)

Builder	Defoe Shipbuilding Co, Bay City, Michigan, USA
Laid down	15 Feb 1965
Launched	5 May 1966
Commissioned	16 Dec 1967
Modernised	1979 (Garden Island Dockyard, Sydney, Australia)
Modernised	1987 (Australia)

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas Harpoon

These ships are fitted for but not with (FFBNW) Harpoon missiles. If carried, they would be held in the after magazine in place of an equal number of SM-1MR and launched from the Mk 13 Mod 6 launcher.

SURFACE-TO-AIR MISSILES (SAM)

Standard Missile-1 Medium Range (SM-1MR)

Main air defence armament is the SM-1MR which is launched from the Mk 13 Mod 6 launcher on the quarterdeck. The below deck magazine holds 40 missiles (but this number might be reduced by also including Harpoon SSMs (see above). When the target is detected the data is evaluated by the ship's command system and the target is designated for the missile fire-control system, which then tracks and illuminates it. The two SPG-51C tracker/illuminator radars usually control one missile each and, once the missile is launched, the tracker's main illumination beam holds the target while the rear reference illuminator beam provides guidance data through the missile's rear reference antenna. This guides the missile until the onboard seeker detects the CW reflected energy from the main illuminator beam at which point the onboard guidance system brings the missile to an interception course.

Specifications
Length: 4.48 m (14.7 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.06 m (3.48 ft)
Weight: 642.3 kg (1,416 lb)
Speed: Mach 2
Range: 25 n miles (46 km)
Height envelope: 50-18,000 m (150-60,000 ft)

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA.
Raytheon, Missile Systems Division, Bedford, Maryland, USA.

TUBES

324 mm Mk 32 triple torpedo launchers

Two triple Mk 32 324 mm torpedo launchers are mounted forward, one either side of the bridge.

TORPEDOES

Honeywell Mk 46 Mod 5 torpedo

Normal armament is the Honeywell Mk 46 Mod 5 anti-submarine torpedo, although some obsolete Mk 44 torpedoes are known to be still in service.

Specification
(Mk 46 Mod 5)
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight:
torpedo: 230 kg (507 lb)
warhead: 44 kg (97 lb)
Speed: 40 kts (max)
Range: 5.9 n miles (11 km)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg; PBXN-103

GUNS

United Defense Mk 42 Mod 10 Single 127 mm (5 in)/54 gun mounting

There are two Mk 42 mountings, each housing a single Mk 18 127 mm/54 gun; one is located on the foredeck,

the other atop the deckhouse aft. The Mk 18 gun has a two-piece barrel with replaceable liner and a service life of some 2,000 rounds. A bayonet-type joint attaches the gun to the housing which includes a vertical sliding breech block and the entire gun assembly is supported on rollers in the slide. A separate rammer is mounted on the slide.

The Mk 42 mounting was introduced in 1953 and the upper part of the mounting is fully power-driven and is enclosed in an armoured shield. The Mk 42 mounting requires a crew of 12: four men within the shield, and eight in the magazine and ammunition handling system.

Ammunition is loaded by a dual system with projectiles supplied automatically to the slide alternately from the right and left. The loading system consists of two manually loaded drums, one with 20 projectiles and the other with 20 charges, which rotate to bring the projectile and cartridge together. Complete rounds are lifted from the lower hoist to the upper hoist and from there to the cradles which move them to the tray from where they are rammed into the breech.

Magazine capacity is 550 rounds and ammunition includes the Mk 41 AAC/HC, Mk 42 common, and Mk 48 illumination rounds, all of which weigh 31.75 kg. All rounds have point detonating, proximity or mechanical time fuzes.

Australian destroyer Brisbane *(D 41) in February 1990. These ships will start to pay off in 1999, as they are replaced by the new ANZAC frigates. This picture was taken prior to the installation of Phalanx CIWS*

Specifications

Gun, 127 mm/54 Mk 18
Calibre: 127 mm
Length of barrel: 54 calibres
Muzzle velocity:
new barrel: 807 m/s (2,650 ft/s)
mid-life: 792 m/s (2,600 ft/s)
Max range: 13 n miles (24 km)
Max altitude: 14,400 m (47,000 ft)
Ammunition: 31.75 kg (70 lb)

Mounting, Mk 42 Mod 10
Traverse: 360° at 40°/s
Elevation: −15 to +85° at 25°/s
Rate of fire: 20-40 rds/min

Manufacturer/Contractor

United Defense Armament Systems Division, Minneapolis, Minnesota, USA.

Hughes Mk 15 CIWS Phalanx

There are two Hughes Mk 15 Phalanx close in weapons systems (CIWS) situated either side of the after stack. The mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n miles (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds. The Australian Navy operates a fleet pool of these mounts, rotating them between the ships.

Specifications

Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor

Hughes Missile Systems, Tucson, Arizona, USA (system).

12.7 mm (0.50 in) M2HB machine guns

Up to six 12.7 mm (0.50 in) M2HB machine guns are carried on board.

Specifications

Calibre: 12.7 mm (0.50 in)
Rate of fire: 450-550 rds/min
Muzzle velocity: 883 m/s (2,900 ft/s)
Max effective range:
anti-surface: 6,700 m (7,400 yd)
anti-air: 1,380 m (4,500 ft)

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

WLR-1H

WLR-1 is a US-manufactured, manually operated, radar warning system covering frequencies from 50 MHz to 10.75 GHz, employing a number of separate antennas.

AN/ULQ-6

AN/ULQ-6 is a US-supplied deception jammer.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher

There are two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications

Launcher
Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

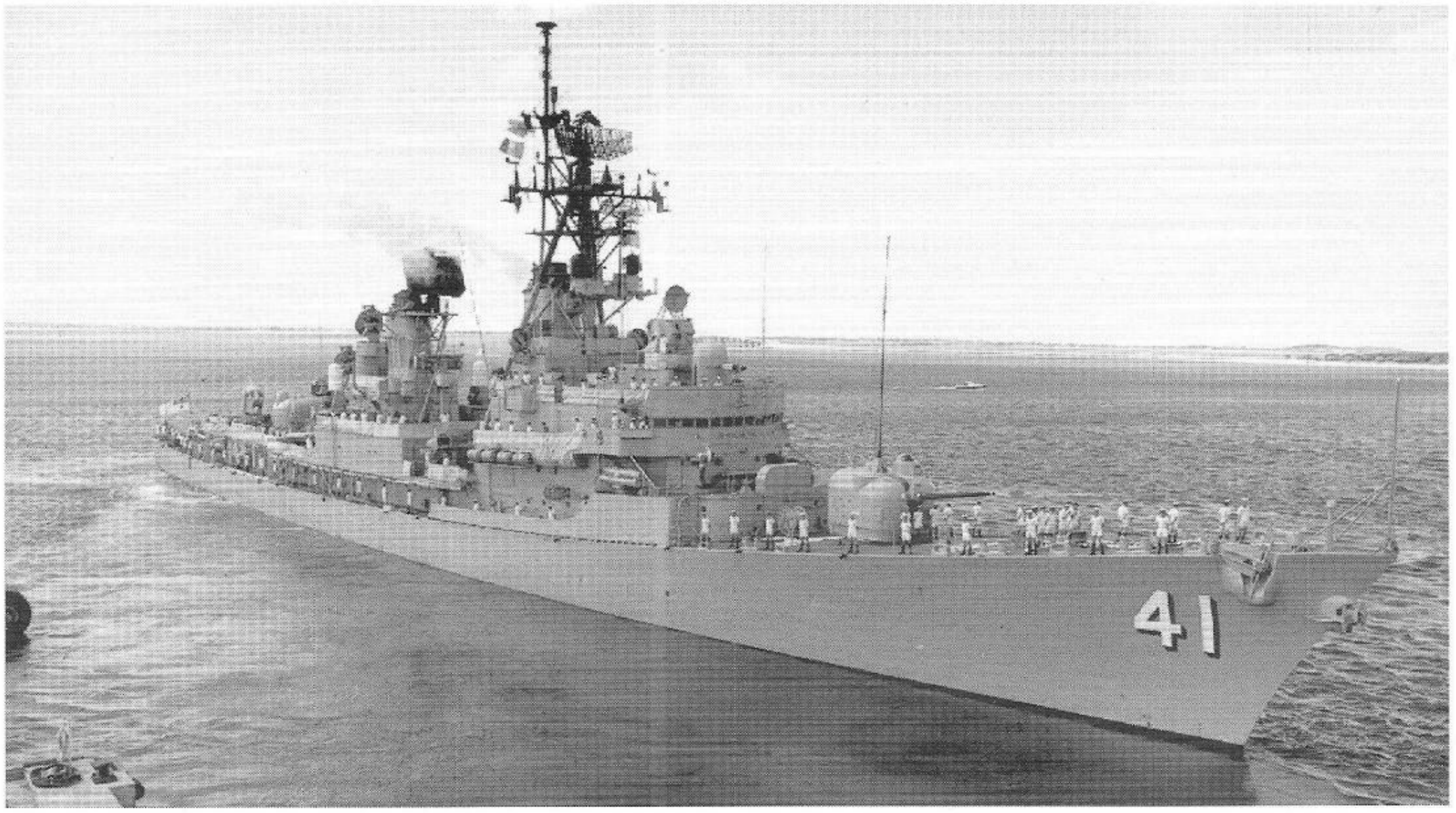
Rounds
Diameter: 130 mm (5.1 in)
Length, weight:
Mk 182: 1,209 mm; 22.7 kg
Super Chaffstar: 1,209 mm; 20.9 kg
Super Gemini: 451 mm; 5.5 kg
Super Hiram III: 1,220 mm; 13.6 kg
Super Hiram IV: 467 mm; 3.8 kg
Super Loroc: 734 mm; 13.2 kg

Manufacturers/Contractors

Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

NULKA expendable rocket-launched hovering decoy system

The Australian NULKA, currently being trialled in *Brisbane,* is an active, expendable, decoy which provides all-weather self-protection for naval vessels against anti-ship missiles. Designed for use either as part of a multi-layer defence system or for stand-alone ship protection, Nulka is based on the Winnin rocket which is held in a hermetically sealed canister which acts both as storage container and launch tube. Control of the decoy's hovering flight is achieved by a thrust control mechanism which acts on the motor's efflux, and a spin control unit mounted on top of the decoy. The combination of thrust and flight control enables successful launches to be made in severe sea state and high wind conditions. Once launched, the decoy operates autonomously and, following its stored flight commands, moves away from the ship at its programmed height and speed to present an alternative and more attractive target to incoming missiles.



Brisbane *with two Phalanx 20 mm CIWS fitted abreast the after stack* (RAN)

Manufacturers/Contractors
AWA Defence Industries (AWADI) Pty Ltd (system).
Sippican, USA (payload).

AN/SLQ-25 Nixie noisemaker

One AN/SLQ-25 Nixie solid-state, electroacoustic countermeasures decoy system is used to protect the ship from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter to generate and amplify the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed over the transom. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. The winch streams and recovers the 488 m (1,600 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408 kg (900 lb). The towed body, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, is 95 cm long (3.10 ft), 15.24 cm (6 in) in diameter and weighs 18 kg (40 lb). It receives amplifier outputs, converts them into acoustic signals and projects them.

Manufacturer/Contractor
Aerojet ElectroSystems, Sacramento, California, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

ACDS Block 0 tactical data handling system

These ships were originally fitted with NTDS, but this has since been upgraded to ACDS (Advanced Combat Direction System) standard. ACDS is an enhanced capability tactical data handling and target designation system, which interfaces with the Missile Fire Control System Mk 74 Mod 13 and the gun fire control system Mk 68. The system includes Univac UYK-7 computers and interfaces with the ships' Link 11.

Manufacturers/Contractors
Unisys (computers).
Hughes Aircraft Company (displays).
Collins (communications.

COMMUNICATIONS AND DATALINKS

Datalink: Link 11
Satcom: OE-2
IFF: AIMS Mk 12
Tacan: URN 20

WEAPONS CONTROL

Mk 68 gun fire control system

The Mk 68 provides target data, position orders and firing orders for the 127 mm (5 in) gun Mk 42 mountings for use against both surface and air targets. The system consists of a Mk 68 gun director, an AN/SPG-53 I/J-band radar, a Mk 47 computer, a Mk 16 stable element and the gun mount. The system requires a crew of eight. The Mk 68 gun director has an optical rangefinder, two handwheels for optical tracking, the radar receiver, transmitter, and antenna as well as a slipring assembly. It transmits bearing, elevation and range data both to the computer and the radar operator's console. It can be operated in automatic radar and optical tracking modes.

The SPG-53F radar incorporates both spiral and conical scan for acquisition and tracking respectively. Later versions have monopulse and low-level tracking capabilities together with splash spotting and a missile launch alarm. The radar has both automatic and manual tracking modes. The former involves transmitting radar error signals in both bearing and elevation to the director power-drive amplifiers, where they are converted into control signals which drive the director. Manual tracking is achieved by operating the range, bearing and elevation handwheels at the radar operator's console. The Mk 47 analogue computer receives inputs from the director, the radar, the stable element, gyrocompass and underwater log system, and processes this data to produce data on future target location, gun position and fuze orders. When engaging air targets its operation is automatic but for engaging surface and land targets manual rate control may be adopted. The Mk 68 can be given a limited electro-optical capability by the Texas Instruments EOSS (Electro-Optical Surveillance System), which may be installed in the Australian ships.

Manufacturer/Contractor
Norden Systems.

Mk 74 Mod 13 missile fire-control system (MFCS)

The Mk 74 acquires, tracks and illuminates targets assigned to it by the weapon direction system. It operates with a missile handling/launching system but is not involved in the launch sequence, which is controlled by the WDS. After missile launching the Mk 74 monitors the weapon and controls it until interception of the target then carries out a post-launch evaluation. The system consists of a computer system, an AN/SPG-51 G/H-I/J-band radar, a Mk 73 director and associated consoles. The system does not use a computer but a CV 3432 radar data processor, instead.

The SPG-51C radar uses a G/H-band pulse Doppler technique for automatic acquisition, tracking and missile guidance. Radar data readouts are displayed upon a dedicated radar console. The I/J-band CW illuminator is used as a reference beam in directing missiles and is detected by the missile's reference antennas as the signal antenna locks on to the energy reflected from the target. By comparing the target-reflected energy and missile rear reference energy it is possible to home the missile.

The SPG-51C radar has two independent channels, each with a G/H-band tracking radar and an I/J-band illumination transmitter. This radar has longer detection and acquisition ranges than its predecessor, and automatic target scheduling, which require fewer operator decisions.

The Mk 73 director is a rotating electronic structure which includes the transmitter group, the control power supply for CW injection, the power supply for the pulse Doppler system, and a radar data converter. It can traverse up to 360° while elevation limits are −30 to +83°. The associated WDS is Mk 14 Mod 5.

Manufacturer/Contractor
Raytheon Company, Equipment Division.

RADARS

Set	AN/SPS-52C	AN/SPS-40C	AN/SPS-67(V)	AN/SPG-53F	Two SPG-51C
Company	Hughes	Lockheed	Norden	Western Electric	Raytheon
Role	Long-range air search	Surface search	Surface search/ navigation	Gun fire control	Missile fire control (SAM)
Band	E/F	E/F	G	G/I	G/I
Range	240 n miles (440 km)	175 n miles (320 km)	–	–	–
Beam	1.1 × 2.25°	11 × 19°	1.5 × 16°	1.6°	Track: 1.6° Illum: 0.9°
Peak power	1,000 kW	200 kW	500 kW	250 kW	Track: 81 kW Illum: 5 kW
Gain	39.5 dB	21 dB	30dB	39 dB	Track: 39.5 dB Illum: 45 dB
Pulsewidth	2.5/4.6/10 µs	60 µs	0.1/0.25/1 µs	0.25 µs	Track: 2.1-3.2 µs
PRF	1,850/925 pps	300 pps	2,400/1,200/750 pps	1,000 pps	Surface: 4.1 kHz Air: 9.5-16.7 kHz
Scan rate	15/6 rpm	7.5/15 rpm	15/30 rpm	–	–

SONARS

Sangamo AN/SQS-23K/L

The SQS-23 dates from 1958 and is a bow-mounted, active, search and attack sonar, operating at medium frequency. Pulse lengths are 2-5, 30 and 120 ms, with base frequencies of 4.5, 5.0 and 5.5 kHz, which can be varied by ±380 Hz to reduce inter-ship interference. Typically, the system has an output of 60 kW while tracking, and a range of some 6 n miles (11 km). The Australian ships use solid-state electronics, which requires three cabinets, in place of the previous vacuum-tube versions' 21 cabinets. The sonar has limited bottom bounce capability.

PROPULSION

Specification
System: Steam
Main machinery: 4 Foster-Wheeler boilers; 84.37 kg/cm² (1,200 psi) at 510°C (950°F) 2 General Electric steam turbines; 52 MW (70,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

After many years of buying British warships the Australian Navy switched to US designs with the 'Perth' class, which were slightly modified versions of the US Navy's 'Charles F Adams' class. The first two, *Perth* and *Hobart*, were ordered in January 1962 and the third a year later. When the US Navy paid off USS *Goldsborough* (DDG 20) in 1992 the hulk was acquired by the Australian Navy to provide spares and equipment for training; what remained was officially scrapped in 1994.

Perth *(D 38) name-ship of a class of three 'Modified Charles F Adams' guided missile destroyers*

DESIGN

The major differences with the original US design lay in the use of the Australian Ikara ASW weapon in place of the US Navy's then current ASROC. This Ikara magazine was housed in a large deckhouse between the stacks, with two single-arm launchers, one on either beam. The system has since been removed and the deckhouse is used for accommodation and recreation.

MODERNISATION

Perth was first modernised in 1974 in the USA with the installation of Standard SM-1MR missiles in place of Tartar, new Mk 42 Mod 10 gun mountings, a new combat data system and modern radars. *Hobart* and *Brisbane* were brought to the same standard in 1978 and 1979 at the Garden Island Dockyard in Sydney, Australia.

A second modernisation programme in the late 1980s involved major equipment upgrades. The AN/SPS-52B three-dimensional radar was upgraded to AN/SPS-52C standard, the search and fire-control radars were replaced, the combat data system and gun systems were upgraded, and the Mk 13 launcher and the magazine were converted to enable them to handle Harpoon missiles. *Brisbane* completed this modernisation in 1987, followed by *Perth* in 1989 and *Hobart* in 1991.

In 1990/91 all ships were fitted to take Phalanx CIWS mountings, particularly for deployments to the Gulf, although the mountings are rotated from one ship to another in a fleet pool system. To create space for the Phalanx system the ship's boats had to be removed and have been replaced by RIBs (rigid inflatable boats). At the same time the obsolete Ikara ASW launchers and magazines were removed, with the below decks space being converted for a variety of other uses, including accommodation and recreation.

OPERATIONAL

On operational deployments these ships are fitted with communications enhancements and portable RAM (radar-absorbent material) panels. All ships are capable of fighter control. Nulka standoff decoys have been installed in *Brisbane* for trials.

They were designed as command and AAW ships, with additional shore bombardment and ASW capabilities. However, the removal of Ikara without replacement by another ASW system and the lack of any helicopter facilities has left these ships with only a very limited anti-submarine capability.

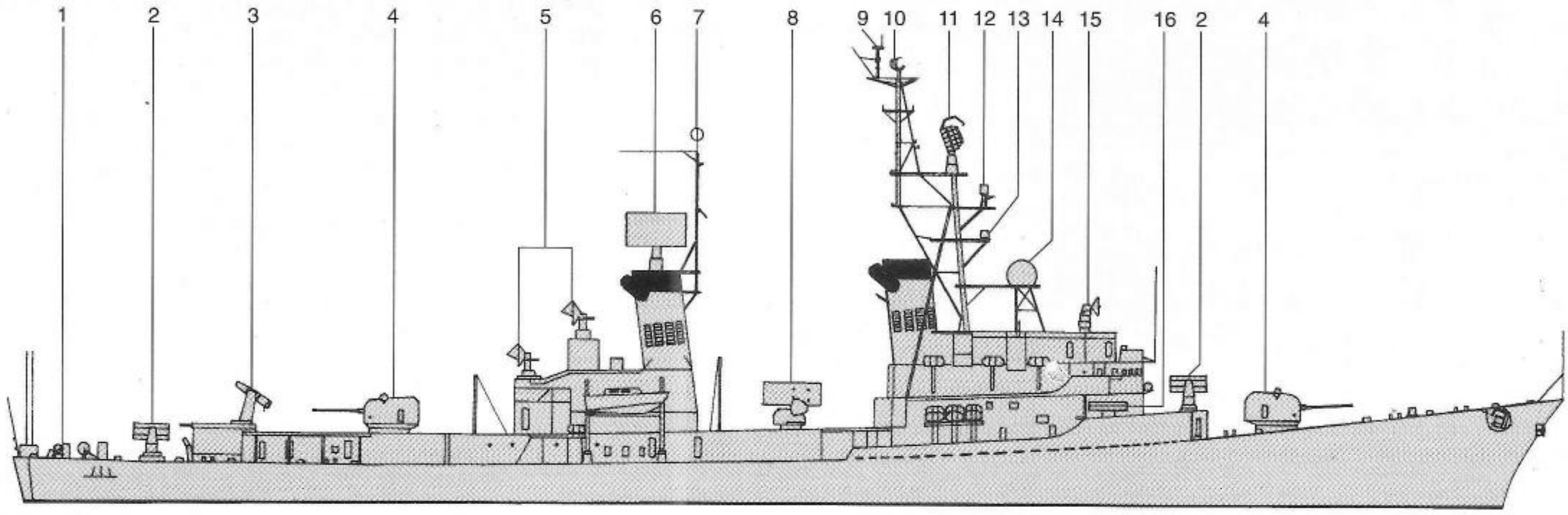
DEPLOYMENT

All three operate from the Fleet Base East at Sydney.

THE FUTURE

The first of class, *Perth*, is due to retire in 1999, followed at intervals by the other two.

LÜTJENS (CHARLES F ADAMS)



Lütjens (Ian Sturton)
1 *Depth Charge projector* **2** *Mk 49 RAM 21-cell launcher* **3** *Mk 13 Mod 0 launcher for standard SM-1MR and Harpoon (total 40 missiles)* **4** *Mk 42 Mod 10 127mm (5 in) single gun mounting* **5** *Raytheon SPG-51 fire directors for Standard SM-1MR* **6** *Hughes SPS-52 3D air search radar* **7** *Communications frequencies direction-finding loop* **8** *Mk 112 ASROC launcher* **9** *URN-20 TACAN* **10** *Raytheon SPS-10 radar (surface search)* **11** *Lockheed SPS-40 radar (air search)* **12** *AEG FL-1800S - DF antennas* **13** *Kelvin Hughes navigation radar* **14** *Lockheed SP2-9 fire-control radar (127 mm guns)* **15** *Lockheed SPG-60 fire control (missle/gun)* **16** *Mk 32 324 mm torpedo launchers (two triple sets)*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Germany
Type: Modified Charles F Adams (SCB-103B)

Class: LÜTJENS

Purchased: 3
Active: 3

Displacement:
standard: 3,370 t
full load: 4,500 t

Dimensions
Length: 133.2 m (437 ft)
Beam: 14.3 m (47 ft)
Draught: 6.1 m (20 ft)

Speed: 32 kts
Range: 4,500 n miles at 20 kts

Complement: 337 (19 officers)

SHIPS

LÜTJENS (D 185)

Builder	Bath Iron Works, Bath, Maine, USA
Laid down	1 Mar 1966
Launched	11 Aug 1967
Commissioned	22 Mar 1969

MÖLDERS (D 186)

Builder	Bath Iron Works, Bath, Maine, USA
Laid down	12 Apr 1966
Launched	13 Apr 1968
Commissioned	20 Sep 1969

ROMMEL (D 187)

Builder	Bath Iron Works, Bath, Maine, USA
Laid down	22 Aug 1967
Launched	1 Feb 1969
Commissioned	2 May 1970

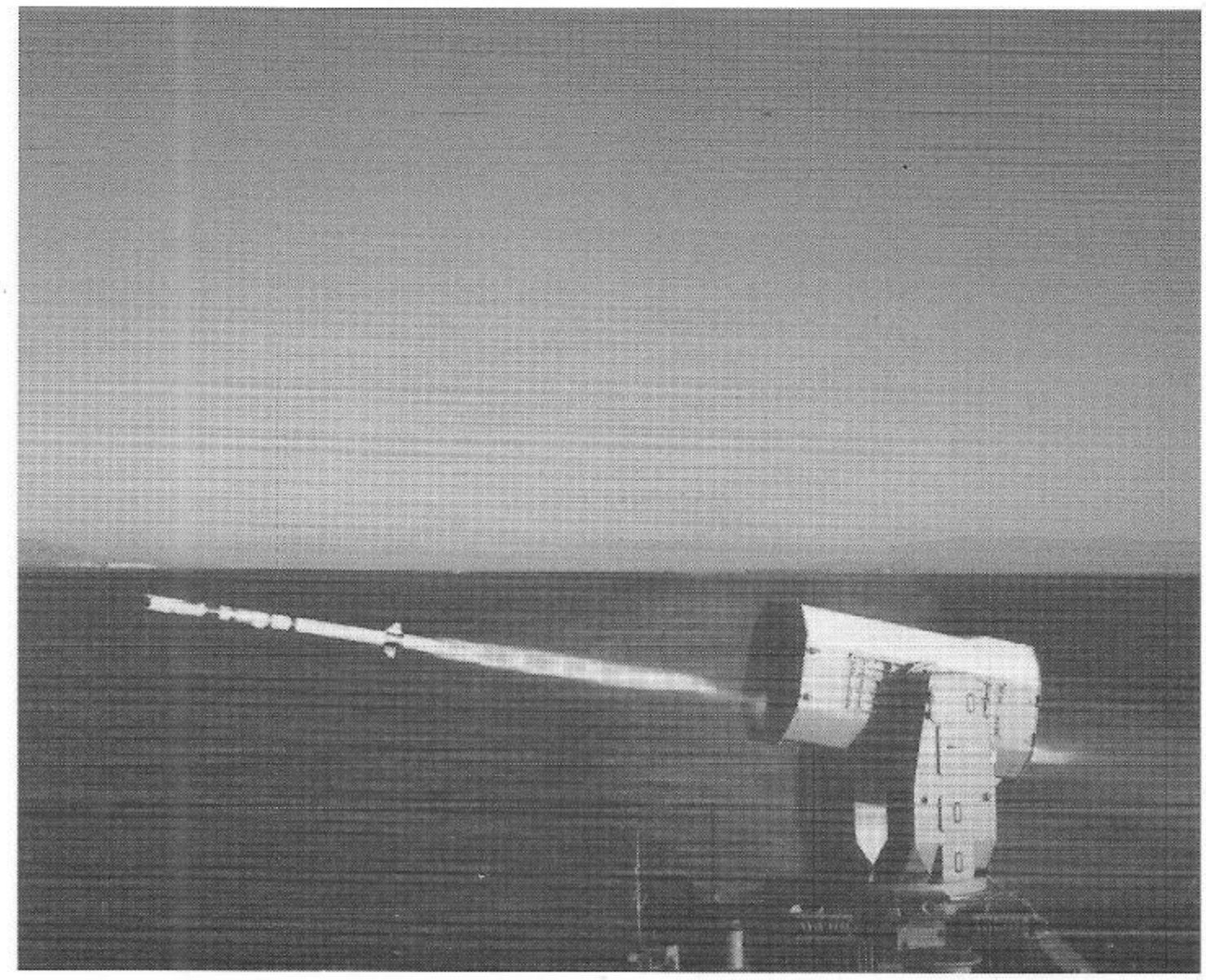
WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas UGM-84B Harpoon

Harpoon anti-ship missiles are carried in the after magazine and launched from the Mk 13 launcher, both of which they share with the Standard SM-1MR SAMs. A total of 40 missiles is carried. The Harpoon missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns and, for the terminal phase, have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)



Test firing a RAM missile at sea (Jane's Naval Weapons Systems)

Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

SURFACE-TO-AIR MISSILES (SAM)

Standard Missile-1 Medium Range (SM-1MR)

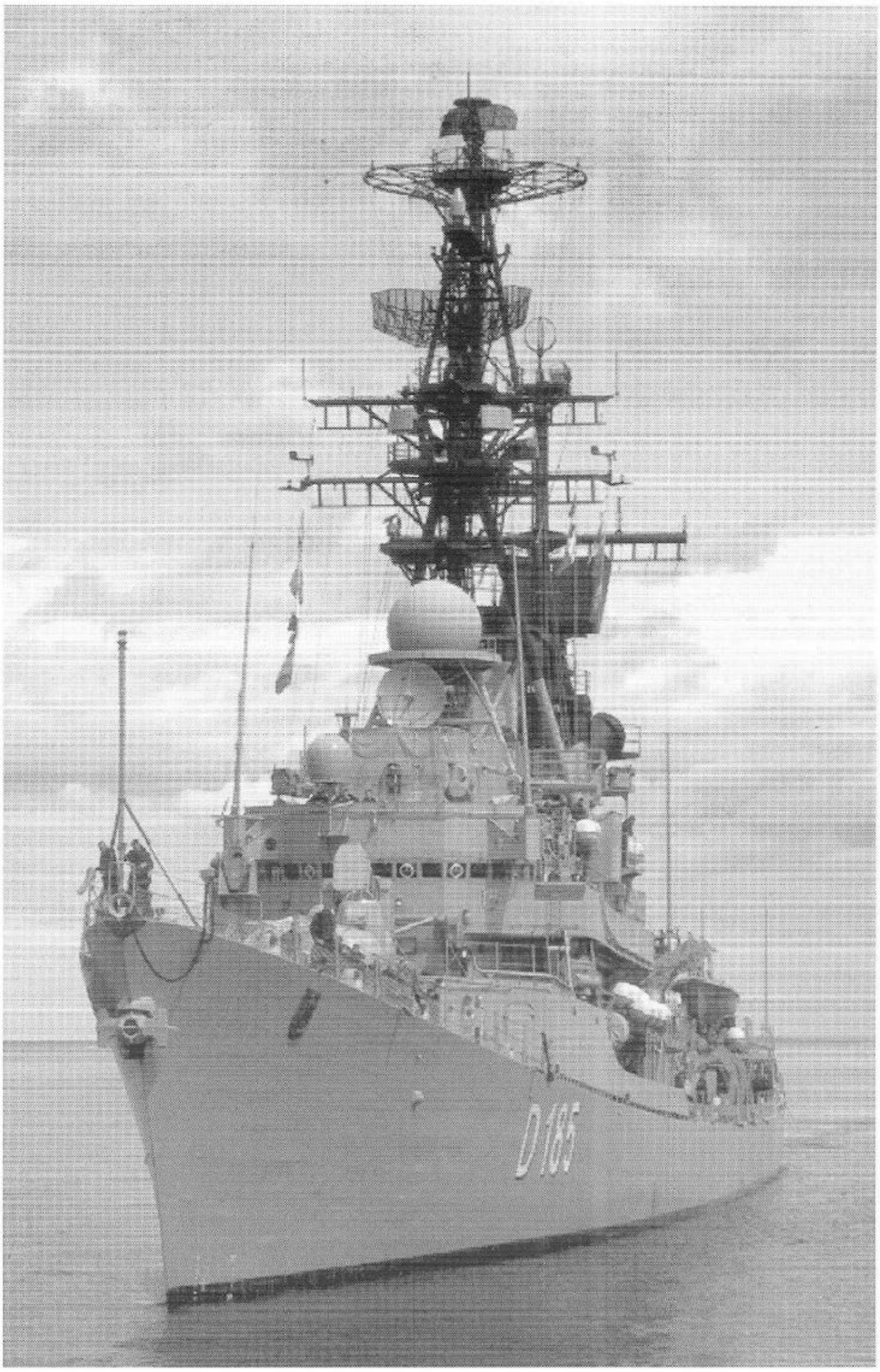
Main air defence armament is the SM-1MR which is launched from the Mk 13 Mod 0 launcher on the quarterdeck. The below deck magazine holds 40 missiles, but this number also includes Harpoon SSMs (see above). When the target is detected the data is evaluated by the ship's command system and the target is designated for the missile fire-control system, which then tracks and illuminates it. Each SPG-51C tracker/illuminator radar usually controls one missile. Once the missile is launched, the tracker's main illumination beam holds the target while the rear reference illuminator beam provides guidance data through the missile's rear reference antenna. This guides the missile until the onboard seeker detects the CW reflected energy from the main illuminator beam. The onboard guidance system then brings the missile to an interception course. SM-1MR Block IV missiles have a Naval Weapon Center Mk 51 expanding rod warhead, while Block V missiles have a Naval Weapon Center Mk 90 blast fragmentation warhead.

Specifications

Length: 4.48 m (14.7 ft)
Diameter: 34.3 cm (13.50 in)
Wing span: 1.06 m (3.48 ft)
Weight: 642.3 kg (1,416 lb)
Speed: Mach 2
Range: 20.5 n miles (38 km)
Altitude: 19,800 m (65,000 ft)

Manufacturers/Contractors

Hughes Missile Systems, Tucson, Arizona, USA.



Lütjens *(D 185) visiting Scotland in 1996* (Jane's/H M Steele)

Raytheon, Missile Systems Division, Bedford, Maryland, USA.

RIM-116A RAM close in system

There are two Mk 49 launchers for the Rolling-Airframe Missile (RAM); one launcher is immediately before the bridge screen, the other right aft. RAM is a lightweight, close in, quick reaction, anti-missile defence system. The RIM-116 missile is based on the Sidewinder air-to-air missile, but with significant modifications, enabling it to be used as a fire-and-forget system. There is an infrared, terminal guidance seeker in the nose (taken from the Stinger manportable surface-to-air missile), behind which is a new dual-mode passive radio frequency seeker for mid-course guidance. Most of the rear of the missile is based upon Sidewinder components.

Missiles are stored in sealed launcher containers, which are manually loaded into the 21-cell Mk 49 RAM Standard Launchers. These launchers are mounted on the same base as that used by the Phalanx and retain that system's elevation and train drive assemblies.

Radar and electro-optical sensors provide details of target location, distance and speed, while the ship's ESM system inputs data on the target's radar frequency, as well as correlating radar data on location. On launch, the missile is spun-up by a rifling band as it is driven down the launch tube, and then as it leaves the launcher the four tail fins deploy which maintains the spin. Aerodynamic control is provided by the two canard surfaces, which also deploy after launch. The autopilot and control system maintain the initial line-of-sight course towards the target and then the RF seeker is activated and once this acquires the target it takes control of the guidance system and makes the appropriate course alterations. The IR seeker is also activated and when a sufficient signal-to-noise ratio is achieved this takes over guidance control for the terminal phase. The missile is capable of manoeuvres up to 20 *g* in any direction.

Specifications

Mk 49 RAM Standard launcher
Traverse: 360°
Elevation: −25 to +80°
Turning circle: 3.27 m

RIM-116 missile
Length: 2.79 m (9.15 ft)
Diameter: 12.7 cm (5 in)
Wing span: 43.4 cm (17 in)
Weight: 73.6 kg (162.26 lb)
Speed: Mach 2
Range: 5.17 n miles (9.6 km)
Warhead: 9.09 kg (20 lb) fragmentation blast WDU-17B
Motor: Hercules/Aerojet Mk 36 solid propellant rocket

Manufacturers/Contractors

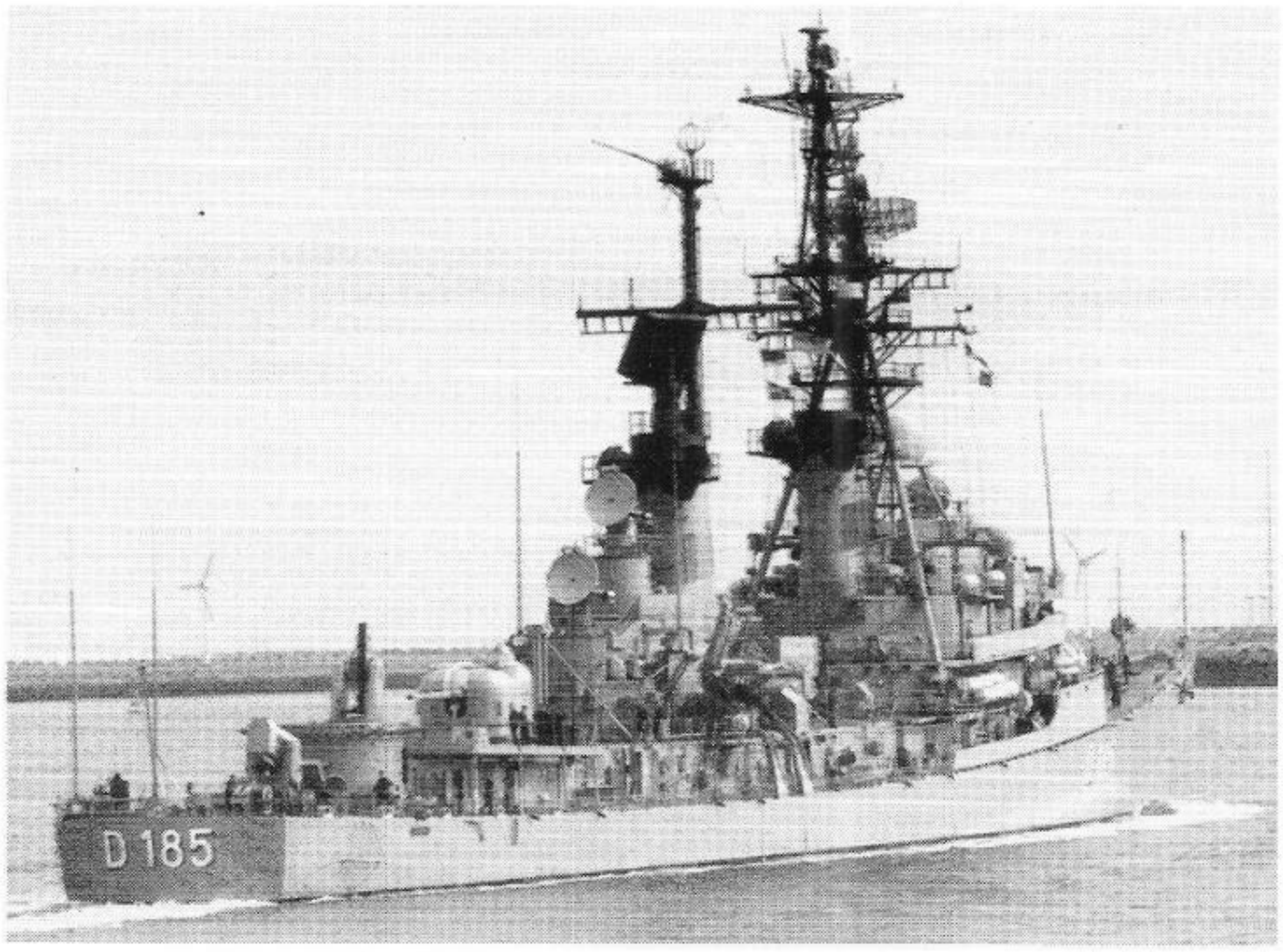
Hughes Missile Systems, Tucson, Arizon, USA.
RAM Systems GmbH; Europe.

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

There is a single Mk 112 launcher in the waist, between the two macks. ASROC consists of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target, including submarines with anechoically coated hulls, and has an estimated acquisition range of 460 m (1,500 ft).

When a submarine target is detected it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between



Lütjens (D 185). Note the RAM launcher on the quarterdeck and the Mk 13 launcher on top of its drum-shaped magazine, which is normally below deck level (H & L van Ginderen Collection)

60 and 305 m (200/1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (2,000 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and, as they separate, the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications

ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor

Honeywell Training and Control Systems, West Covina, California.

TORPEDOES

324 mm Mk 32 triple torpedo launchers

Two triple Mk 32 324 mm torpedo launchers are mounted forward, one either side of the bridge.

Mk 46 Mod 2 torpedo

Armament is the Honeywell Mk 46 Mod 2 anti-submarine torpedo.

Specifications

(Mk 46 Mod 2)
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight:
torpedo: 230 kg (507 lb)
warhead: 44 kg (97 lb)
Speed: 40 kts (max)
Range: 5.9 n miles (11 km)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg; PBXN-103

GUNS

United Defense Mk 42 Mod 10 Single 127 mm (5 in)/54 gun mounting

There are two Mk 42 mountings, each housing a single Mk 18 127 mm/54 gun; one is located on the foredeck, the other atop the deckhouse aft. The Mk 18 gun has a two-piece barrel with replaceable liner and a service life of some 2,000 rounds. A bayonet-type joint attaches the gun to the housing which includes a vertical sliding breech block and the entire gun assembly is supported on rollers in the slide. A separate rammer is mounted on the slide.

The Mk 42 mounting was introduced in 1953 and the upper part of the mounting is fully power-driven and is enclosed in an armoured shield. The Mk 42 mounting requires a crew of 12: four men within the shield, and eight in the magazine and ammunition handling system.

Ammunition is loaded by a dual system with projectiles supplied automatically to the slide alternately from the right and left. The loading system consists of two manually loaded drums, one with 20 projectiles and the other with 20 charges, which rotate to bring the projectile and cartridge together. Complete rounds are lifted from the lower hoist to the upper hoist and from there to the cradles which move them to the tray from where they are rammed into the breech.

Magazine capacity is 550 rounds and ammunition includes the Mk 41 AAC/HC, Mk 42 common, and Mk 48 illumination rounds, all of which weigh 31.75 kg. All rounds have point detonating, proximity or mechanical time fuzes.

Specifications

Gun, 127 mm/54 Mk 18
Calibre: 127 mm (5 in)
Length of barrel: 54 calibres
Muzzle velocity:
new barrel: 807 m/s (2,650 ft/s)
mid-life: 792 m/s (2,500 ft/s)
Max range: 13 n miles (24 km)
Max altitude: 14,400 m (47,000 ft)
Ammunition: 31.75 kg

Mounting, Mk 42 Mod 10
Traverse: 360° at 40°/s
Elevation: −15 to +85° at 25°/s
Rate of fire: 20-40 rds/min

Manufacturer/Contractor

United Defense Armament Systems Division, Minneapolis, Minnesota, USA.

DEPTH CHARGES

There is one depth charge projector, but the type of weapon used is not known.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

FL-1800S Stage II ECM/ESM suite

The FL-1800S Stage II, now installed in all three ships, is based on the FL-1800S, but with considerable improvements in the areas of signal processing, analysis, MMIC and ECM. There is a new channelised receiver with nine sub-bands, which provides extremely accurate frequency measurement and CW resistance. Two fully integrated superheterodyne receivers have been incorporated for special analysis of pulses and for later upgrade to fit in a Fingerprinting System. The system remains wide open to receive other threats. Expanded capacity threat libraries are provided with onboard reprogrammable modules for use in out-of-area missions.

Specifications

(ESM)
Frequency range: 2-18 GHz
Azimuth coverage: 360°
Elevation coverage: −10 to +60°
Polarisation: 45° linear for receiving channel; circular for DF
DF accuracy: 5° typical RMS

Manufacturer/Contractor

Daimler-Benz Aerospace AG, Sensor Systems Division, Ulm, Germany.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher

There are two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications

Launcher
Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

STN Atlas BM 802-52 console in the SATIR system

Rounds
Diameter: 130 mm (5.1 in)
Length, weight:
Mk 182: 1,209 mm; 22.7 kg
Super Chaffstar: 1,209 mm; 20.9 kg
Super Gemini: 451 mm; 5.5 kg
Super Hiram III: 1,220 mm; 13.6 kg
Super Hiram IV: 467 mm; 3.8 kg
Super Loroc: 734 mm; 13.2 kg

Manufacturers/Contractors
Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

SATIR Z103B tactical data handling system
SATIR *(System zur Auswertung Taktischer Informationen auf Raketenzerstoerren)* is a command and weapon control system *(Führungs und Waffeneinsatzsystem* (FüWes)). The hardware and software have been integrated by the *Bundesamt für Wehrtechnik und Beschaffung* (BWB) and the *Kommando Marine Führungssystems* (KdoMFüSys) and then interfaced with sensor and weapon systems. The original system was SATIR Z103 which was fitted in the three 'Lütjens' class ships and entered service in March 1969, but in the early 1980s these systems were upgraded to SATIR Z103B standard to achieve commonality with the systems then being installed in the F122 frigates. The first Z 103B system entered service in March 1984 aboard *Mölders*.

SATIR is a mainframe architecture system using BWB software written in the CMS-2Y language, the SATIR Z103B version being based on a dual-bay 32-bit AN/UYK-7 with a 256 k memory and an operating speed of 667 Kops. The system is designed to acquire data from a variety of sensors, and to process and display it to ensure effective engagement of airborne, surface and subsurface targets. A modular software structure was adopted and four packages were produced for operations, maintenance, support and administration. Radar video data is transmitted both directly to the display consoles and, via the video extractor, to the central computer and there is partial integration of the IFF system.

SATIR Z103B uses the Hughes AN/UYA-4 display system family and has 11 OJ-7879 consoles for general sensor data display, two OJ-194 consoles for use with the AN/SYS-1(V)1 data fusion system and one for the FL-1800S Stage II ECM system, as well as an IP-1117 range-height indicator console.

Manufacturers/Contractors
BWB (prime).
Unisys (subcontractor 1).
Atlas Elektronik (subcontractor 2).

COMMUNICATIONS AND DATALINKS

Link 11
Satcom
Tacan: URN 20.

WEAPONS CONTROL

Gun Fire Control System (GFCS) Mk 86 Mod 8
The GFCS Mk 86 replaced the GFCS Mk 68 during the German ships' modernisation programme. GFCS Mk 86 controls direct and indirect naval gun fire support and also assists in the engagement of both surface and air targets. It has a mainframe architecture using CMS-2 software language and consists of a computer system, a display system and three sensors, and accepts data from ACDS, the Mk 74 fire-control system and optical Target Designation Transmitters. The Mk 86 Mod 8 system installed in the 'Lütjens' class is configured to control the two 127 mm guns for defence against surface and air targets, and for shore bombardment. It uses two AN/UYK-7 32-bit computers, each with a memory of 256,000 words and an operating speed of 667,000 operations per second. The system can track 120 targets simultaneously.

Targets acquired by the ship's search radars, missile fire-control radars and EW system are evaluated by the Combat Information Center (CIC) which designates them to the Mk 86 Combat Operations Center (COC). They are then assigned to a Weapons Operations Center (WOC) together with a gun or guns for acquisition and tracking which are monitored by the COC operator. The WOC operator checks the ballistic solution and commands the loading and firing of the gun or guns.

Several operational modes are available:

Radar Surface Fire. Upon target acquisition, a track-while-scan routine is used to track simultaneously multiple designated targets. Smoothed radar data with appropriate ballistics data, are used to compute weapon orders.

Air Action. The computer automatically and adaptively controls search patterns to acquire and track air targets. Target data, plus a TV view along the SPG-60 boresight axis, are displayed on a weapon control console. The engagement with SM-2 missiles is facilitated by virtue of continuous wave illumination injection to the SPG-60 tracking radar. A pre-action calibration of gun weapons can be initiated from the weapon control consoles.

Anti-Ship Missile Defense (ASMD). The track-while-scan acquisition gate is expanded to a range sufficient for threat detection. (Full 360° coverage, or coverage over a number of segments to provide surveillance of selected areas, can be chosen.) All targets passing through the acquisition gate are then automatically detected by the system. After target detection, the following functions are performed automatically: threat evaluation; weapon assignment; assignment of targets to tracking channels; slewing of AA director and a weapon to the target; scan of AA director and 3D track of targets; initiation of firing; and transfer of fire to second target.

Visual Surface Fire. A future facility will allow the weapon controller to track the target visually with the TV system and fire the laser to obtain range data. Target range and angle data are entered into the system automatically, and ballistics are computed.

Indirect Shore Bombardment. For shore fire support missions or engagement of targets that are not within view of either radar or optical sensors, target and 'own ship' co-ordinates are entered at a weapon control console. The system automatically updates these with inputs from the ship's compass and log, or by means of a beacon or other navigational aids. Spotting data is entered at the keyboard. Automatic compensation for orientation of the target line by an on-shore observer is provided.

Manufacturer/Contractor
Lockheed Electronics Company Inc, Nashua, New Hampshire, USA.

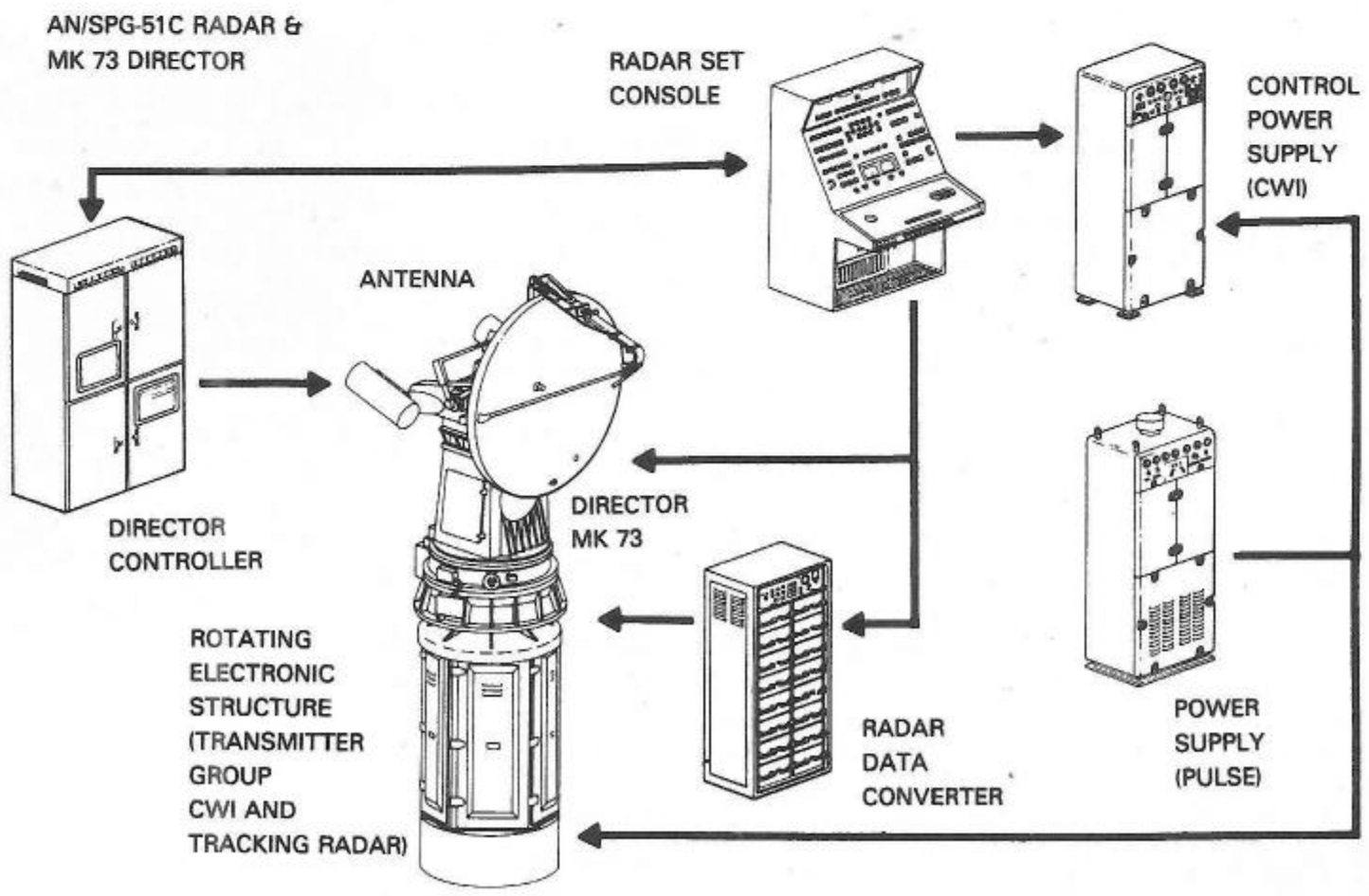
Mk 74 Mod 6 missile fire-control system (MFCS)
The Mk 74 acquires, tracks and illuminates targets assigned to it by the weapon direction system. It operates with a missile handling/launching system but is not involved in the launch sequence, which is controlled by the Weapon Direction System (WDS). After missile launching the Mk 74 monitors the weapon and controls it until interception of the target then carries out a post-launch evaluation. The system consists of a computer system, an AN/SPG-51 G/H-I/J-band radar, a Mk 73 director and associated consoles. The system uses a Mk 152 Mod 1 computer.

The SPG-51C radar uses a G/H-band pulse Doppler technique for automatic acquisition, tracking and missile guidance. Radar data readouts are displayed upon a dedicated radar console. The I/J-band CW illuminator is used as a reference beam in directing missiles and is detected by the missile's reference antennas as the signal antenna locks on to the energy reflected from the target. By comparing the target-reflected energy and missile rear reference energy it is possible to home the missile.

The SPG-51C radar has two independent channels each with a G/H-band tracking radar and an I/J-band illumination transmitter. This radar has longer detection and acquisition ranges than its predecessor, and automatic target scheduling, which require fewer operator decisions.

The Mk 73 director is a rotating electronic structure which includes the transmitter group, the control power supply for CW injection, the power supply for the pulse Doppler system, and a radar data converter. It can traverse up to 360° while elevation limits are −30 to +83°. The associated WDS is the Mk 14 Mod 5.

Manufacturer/Contractor
Raytheon Company, Equipment Division.



The Mk 74 MFCS controls the Standard SM-1MR in flight, using the SPG-51 radar, Mk 73 director and a Mk 152 Mod 1 computer (Raytheon)

RADARS

Set	AN/SPS-40C	AN/SPS-52B	AN/SPS-10	Two AN/SPG-51C	AN/SPQ-9	AN/SPG-60
Company	Lockheed	Hughes	Raytheon	Raytheon	Lockheed	Lockheed
Role	2D surface search	3D long-range air search	Surface search	Missile fire control (SAM)	Gunfire control	Missile/gun fire control
Band	E/F	E/F	G	G/I	I/J	I/J
Range	175 n miles (320 km) 50,000 ft	240 n miles (440 km)	Can detect a destroyer at 15 n miles	—	20 n miles (37 km) 610 m	60 n miles (110 km)
Beam	11 × 19°	1.1 × 2.25°	1.5 × 16°	Track: 1.6° Illum: 0.9°	1.35 × 3°	1.2 × 1.2°
Peak power	200 kW	1 MW	285 kW	Track: 81 kW Illum: 5 kW	1.2 kW	5.5 kW
Gain	21 dB	39.5 dB	30 dB	Track: 39.5 dB Illum: 45 dB	37 dB	41.5 dB
Pulsewidth	60 µs	4.6/10/2.5 µs	0.25-1.3 µs	Track: 2.1-3.2 µs	0.3-16 µs	0.27/1/6 µs
PRF	300 pps	1,850/925 pps	312-325 pps	Surface: 4.1 kHz Air: 9.5-16.7 kHz	3,000 pps	25,000-35,000 pps
Scan rate	7.5/15 rpm	7.5/7.5/15 rpm	15 rpm	—	60 rpm	—

SONAR

STN Atlas Elektronik DSQS-21BZ hull-mounted and variable depth sonar systems

DSQS-21BZ has a 1 m diameter hull-mounted, medium-frequency transducer array, with 32 preformed beams. It uses computer-aided detection techniques for classification and tracking and the information is presented on colour CRT displays to permit Doppler coding and the discrimination of data on the integrated displays. The sonar system can automatically transmit up to 10 targets directly into SATIR.

(Note: The 'Z' in the designation indicates a variant equipped with electronic stabilisation to minimise the effects of ship's motion)

Manufacturer/Contractor

STN Atlas Elektronik GmbH, Bremen, Germany.

PROPULSION

Specifications
System: Steam turbine
Main machinery: 4 Combustion Engineering boilers; 84.4 kg/cm² (1,200 psi); 510°C (950°F); 2 turbines; 52.2 MW (70,000 hp)
Shafts: 2

Lütjens *is one of three 'Charles F Adams' class destroyers serving in the German Navy* (H & L van Ginderen Collection)

FURTHER INFORMATION

PROGRAMME

The German Navy originally planned to order six ships of this class, all of which would have been built in West German yards. In the event, however, it was decided to reduce the order to three ships, all of which would be built in the United States, and an inter-government agreement was signed in 1964, with the order placed in 1965.

DESIGN

As built, the German ships were fitted with weapons, sensors and propulsion systems identical to those in the late production ships for the US Navy. A number of relatively minor changes were, however, made to bring the ships in line with German practice, principally by fitting modified stacks, with sideways projecting exhausts. In addition, the SPS-52 antenna was placed on top of the stack and the small platform ahead of the stack was used as the base for a rather more substantial mainmast.

MODERNISATION

These three ships have undergone repeated modernisations. In the late 1970s the boilers were modified to enable them to burn light oil. A major modification programme was undertaken in the mid-1980s, which included: replacing Tartar SAMs by Standard; installing a single-arm Mk 13 launcher for Standard SAM and Harpoon SSM; improved fire control with digital in place of analogue computers; and a raised superstructure abaft the bridge with the SPG 60 and SPQ 9 antennas on a mast platform. This work was carried out by the Naval Arsenal, Kiel and Howaldtswerke, Kiel, with *Mölders* completed on 29 March 1984, *Rommel* on 26 Jul 1985, and *Lütjens* on 16 December 1986.

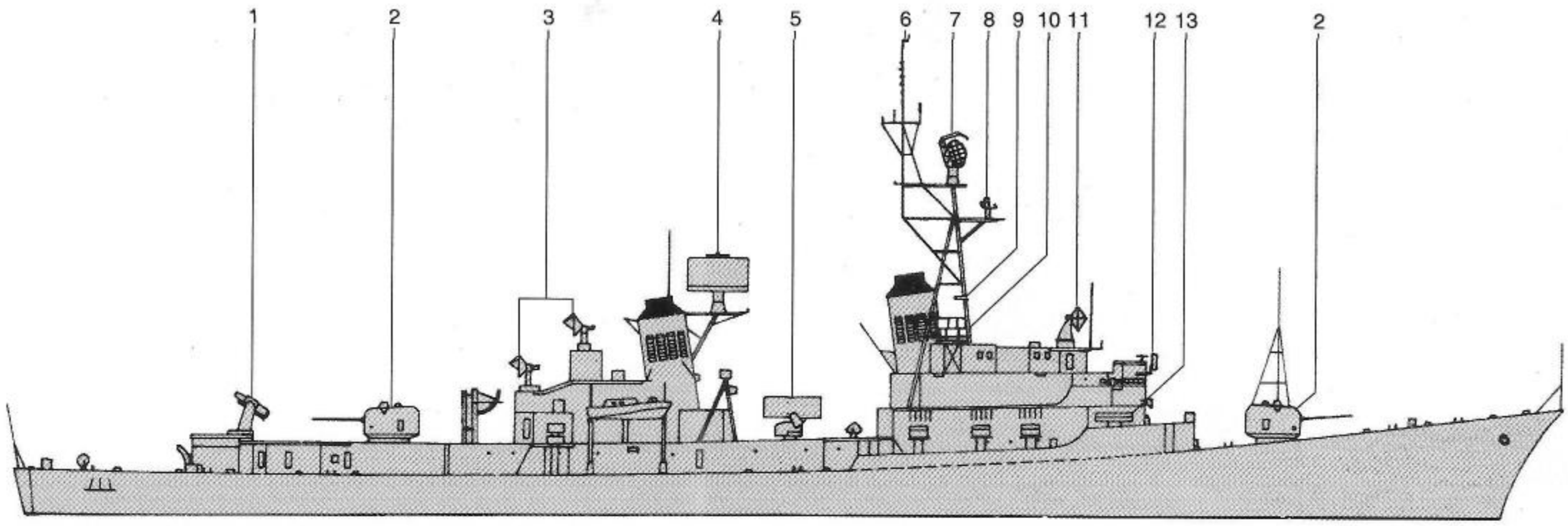
The most recent upgrading has involved fitting the two RAM launchers. This system became operational in *Mölders* in December 1993, followed by *Lütjens* in June 1995 and, finally, *Rommel* in July 1996. The electronic warfare suites have also been upgraded in 1995/96.

THE FUTURE

These ships were planned to have a life of at least 30 years, taking them to 1999 *(Lütjens* and *Mölders)* and 2000 *(Rommel).* However, there have been recent problems with the boilers, which, coupled with budgetary cuts, may lead to earlier retirement. The successor is the Sachsen (F124) class.

Lütjens *(D 185). The circular disk at the mast-head is URN-25 TACAN and on the platform below it is the SPS-10 surface search radar. The small cylinder with a pointed top is the omni-directional antenna element of the FL-1800S ESM/ECM suite. The large antenna is the SPS-40 air search radar and below that are four rectangular antennas, one in each quadrant, which are the DF antenna system of FL-1800S. The large football radome covers the SPQ-9 fire-control radar, in front of which is the SPG-60 fire-control radar for the RAM missile system. The satellite communication antenna on the bridge roof is for INMARSAT, while the small rectangular antenna halfway up the rear strut of the foremast (directly below the forward exhaust) is the jammer element of FS-1800S*

KIMON (CHARLES F ADAMS)



Kimon (Ian Sturton)
1 *Mk 13 launcher (40 missiles: 6 Harpoon; 34 Standard SM-1MR)* **2** *Mk 42 127 mm (5 in)/54 single automatic mount* **3** *Raytheon SPG-510 fire control (for Standard SM-1MR)* **4** *Hughes SP5-52B/C radar (air search)* **5** *Mk 112 ASROC eight-cell launcher* **6** *URN-25/SRN-6 TACAN* **7** *Lockheed SP5-40B/D radar* **8** *Raytheon SPS-10D/F radar (surface search)* **9** *Canadian-Marconi LN-66 radar (navigation)* **10** *SLQ-32(v)2 ESM (radar warning)* **11** *Lockheed SPG-53A fire control (guns)* **12** *Satcom* **13** *Mk 32 324 mm torpedo launcher (two triple sets)*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: Greece
Type: Charles F Adams

Class: KIMON

Leased: 4
Active: 4

Displacement:
standard: 3,370 t
full load: 4,825 t load

Dimensions
Length: 133.2 m (437 ft)
Beam: 14.3 m (47 ft)
Draught
hull: 4.8 m (15.6 ft)
sonar: 6.4 m (21 ft)

Speed: 30 kts
Range: 6,000 n miles at 15 kts; 1,600 n miles at 30 kts

Complement: 340 (22 officers)

SHIPS

KIMON (D 218)

Builder	Avondale Shipyard, Westwego, Louisiana, USA
Laid down	18 Aug 1960
Launched	20 May 1961
Commissioned (US Navy)	10 Dec 1962 (*Semmes* (DDG 18))
Recommissioned	12 Sep 1992

NEARCHOS (D 219)

Builder	Todd Pacific Shipyard, Seattle, Washington, USA
Laid down	6 Feb 1962
Launched	26 Feb 1963
Commissioned (US Navy)	28 Aug 1964 (*Waddell* (DDG 24))
Recommissioned	1 Oct 1992

FORMION (D 220)

Builder	New York Shipbuilding, Camden, New Jersey, USA
Laid down	27 Dec 1960
Launched	9 Dec 1961
Commissioned (US Navy)	20 Apr 1963 (*Strauss* (DDG 16))
Recommissioned	1 Oct 1992

THEMISTOCLES (D 221)

Builder	New York Shipbuilding, Camden, New Jersey, USA
Laid down	1 June 1960
Launched	29 Jul 1961
Commissioned (US Navy)	15 Dec 1962 (*Berkeley* (DDG 15))
Recommissioned	1 Oct 1992

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas RGM-84B Harpoon

Six Harpoon anti-ship missiles are carried in the after magazine and launched from the Mk 13 launcher, both of which they share with 34 Standard SM-1MR SAMs. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns and, for the terminal phase, have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications
(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

SURFACE-TO-AIR MISSILES (SAM)

Standard Missile-1 Medium Range (SM-1MR)

Main air defence armament is the SM-1MR which is launched from the Mk 13 Mod 0 launcher on the quarterdeck. The below deck magazine holds 40 missiles, but this number also includes six Harpoon SSMs (see above), leaving space for 34 SM-1MR. When the target

Nearchos *(D 219) shows all the systems carried by these capable ships. The two guns in 'A' and 'X' positions are Mk 18 127 mm (5 in)/54s, while there is a single Mk 13 launcher for Standard SM-1MR in 'Y' position and an eight-cell ASROC launcher amidships. Main radars are the SPS-40 at the foretop, SPS-52 atop the after stack, and the two SPG-51s to control the Standard missiles* (Jane's/H M Steele)

is detected, the data is evaluated by the ship's command system and the target is designated for the missile fire-control system, which then tracks and illuminates it. Each SPG-51C tracker/illuminator radar usually controls one missile. Once the missile is launched, the tracker's main illumination beam holds the target while the rear reference illuminator beam provides guidance data through the missile's rear reference antenna. This guides the missile until the onboard seeker detects the CW reflected energy from the main illuminator beam. The onboard guidance system then brings the missile to an interception course. SM-1MR Block IV missiles have a Naval Weapon Center Mk 51 expanding rod warhead, while Block V missiles have a Naval Weapon Center Mk 90 blast fragmentation warhead.

Specifications
Length: 4.48 m (14.7 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.06 m (3.48 ft)
Weight: 642.3 kg (1,416 lb)
Speed: Mach 2
Range: 20.5 n miles (38 km)
Altitude: 46-18,300 m (150-60,000 ft)

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA.
Raytheon, Missile Systems Division, Bedford, Maryland, USA.

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC
There is a single Mk 16 octuple launcher in the waist, between the two macks. ASROC consists of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. The torpedo has a dome-shaped frangible plastic nose cap to protect the transducer as it enters the water. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target, including submarines with anechoically coated hulls, and has an estimated acquisition range of 460 m (1,500 ft).

When a submarine target is detected it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 and 305 m (200/1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (2,000 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and, as they separate, the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Specifications
ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9

Mk 46 Mod 5 torpedo
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight: 230 kg (507 lb)
Speed: 40 kts (max)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

Manufacturer/Contractor
Honeywell Training and Control Systems, West Covina, California.

TORPEDOES

324 mm Mk 32 triple torpedo launchers
Two triple Mk 32 324 mm torpedo launchers are mounted forward, one either side of the bridge.

Mk 46 Mod 2 torpedo
Armament is the Honeywell Mk 46 Mod 2 anti-submarine torpedo.

Specification
(Mk 46 Mod 2)
Diameter: 324 mm (12.75 in)
Length: 2.95 m (9.68 ft)
Weight:
torpedo: 230 kg (507 lb)
warhead: 44 kg (97 lb)
Speed: 40 kts (max)
Range: 5.9 n miles (11 km)
Homing: Active/passive acoustic homing head
Motor: 5-cylinder liquid mono-propellant (Otto) motor
Warhead: Mk 103 Mod 1; 44 kg (97 lb); PBXN-103

GUNS

United Defense Mk 42 Mod 10 Single 127 mm (5 in)/54 gun mounting
There are two Mk 42 mountings, each housing a single Mk 18 127 mm/54 gun; one is located on the foredeck, the other atop the deckhouse aft. The Mk 18 gun has a two-piece barrel with replaceable liner and a service life of some 2,000 rounds. A bayonet-type joint attaches the gun to the housing which includes a vertical sliding breech block and the entire gun assembly is supported on rollers in the slide. A separate rammer is mounted on the slide.

The Mk 42 mounting was introduced in 1953 and the upper part of the mounting is fully power-driven and is enclosed in an armoured shield. The Mk 42 mounting requires a crew of 12: four men within the shield, and eight in the magazine and ammunition handling system.

Ammunition is loaded by a dual system with projectiles supplied automatically to the slide alternately from the right and left. The loading system consists of two manually loaded drums, one with 20 projectiles and the other with 20 charges, which rotate to bring the projectile and cartridge together. Complete rounds are lifted from the lower hoist to the upper hoist and from there to the cradles which move them to the tray from where they are rammed into the breech.

Magazine capacity is 550 rounds and ammunition includes the Mk 41 AAC/HC, Mk 42 common, and Mk 48 illumination rounds, all of which weigh 31.75 kg (70 lb). All rounds have point detonating, proximity or mechanical time fuzes.

Specifications
Gun, 127 mm/54 Mk 18
Calibre: 127 mm (5 in)
Length of barrel: 54 calibres
Muzzle velocity:
new barrel: 807 m/s (2,650 ft/s)
mid-life: 792 m/s (2,600 ft/s)
Max range: 13 n miles (24 km)
Max altitude: 14,400 m (47,000 ft)
Ammunition: 31.75 kg

Mounting, Mk 42 Mod 10
Traverse: 360° at 40°/s
Elevation: −15 to +85° at 25°/s
Rate of fire: 20-40 rds/min

Manufacturer/Contractor
United Defense Armament Systems Division, Minneapolis, Minnesota, USA.

Machine guns
Up to four 12.7 mm (0.50 in) M2HB machine guns are carried on board.

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES (ESM)

AN/SLQ-32(V)2 ESM Suite

These Greek ships have the AN/SLQ-32(V)2 EW suite, which gives radar warning on B- to J-bands. (Note that AN/SLQ-32(V)2 does not have an active jamming element, which only comes with the AN/SLQ-32(V)3 or AN/SLQ-32(V)5 suites.

Manufacturer/Contractor

Raytheon Company, Electromagnetic Systems Division, Goleta, California.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher

There are two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units.

Specifications

Launcher
Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Rounds
Diameter: 130 mm (5.1 in)
Length, weight:
Mk 182: 1,209 mm; 22.7 kg
Super Chaffstar: 1,209 mm; 20.9 kg
Super Gemini: 451 mm; 5.5 kg
Super Hiram III: 1,220 mm; 13.6 kg
Super Hiram IV: 467 mm; 3.8 kg
Super Loroc: 734 mm; 13.2 kg

Manufacturers/Contractors

Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

T-Mk 6 Fanfare

The T-Mk 6 torpedo decoy consists of two winches each with a cable and a 'fish' containing a mechanical acoustic device. It was introduced into the US Navy in the 1950s and has been replaced in most ships by AN/SLQ-25 Nixie.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS AND DATALINKS

Command system: STACOS being fitted
Datalinks: Link 11; Link 14 (receive only)
IFF: Mk XII.

WEAPONS CONTROL

Mk 68 gun fire control system

The Mk 68 provides target data, position orders and firing orders for the 127 mm (5 in) gun Mk 42 mountings for use against both surface and air targets. The system consists of a Mk 68 gun director, an AN/SPG-53 I/J-band radar, a Mk 47 computer, a Mk 16 stable element and the gun mount. The system requires a crew of eight. The Mk 68 gun director has an optical rangefinder, two handwheels for optical tracking, the radar receiver, transmitter, and antenna as well as a slipring assembly. It transmits bearing, elevation and range data both to the computer and the radar operator's console. It can be operated in automatic radar and optical tracking modes.

The SPG-53F radar incorporates both spiral and conical scan for acquisition and tracking respectively. Later versions have monopulse and low-level tracking capabilities together with splash spotting and a missile launch alarm. The radar has both automatic and manual tracking modes. The former involves transmitting radar error signals in both bearing and elevation to the director power-drive amplifiers, where they are converted into control signals which drive the director. Manual tracking is achieved by operating the range, bearing and elevation handwheels at the radar operator's console. The Mk 47 analogue computer receives inputs from the director, the radar, the stable element, gyrocompass and underwater log system, and processes this data to produce data on future target location, gun position and fuze orders. When engaging air targets its operation is automatic but, for engaging surface and land targets, manual rate control may be adopted. The Mk 68 can be given a limited electro-optical capability by the Texas Instruments EOSS (Electro-Optical Surveillance System), which may be installed in the Australian ships.

Manufacturer/Contractor

Norden Systems.

Weapons Direction System (WDS) Mk 4 Mod 1

WDS Mk 4 was the Tartar system installed in the US Navy's 'Charles F Adams' class destroyers, Mod 1 being the version fitted in DDG 15 to DDG 24, which includes the four Greek ships. WDS Mk 4 Mod 1 is an analogue system and incorporates WDE Mk 1-1 (Weapons Direction Equipment)

Mk 74 Mod 13 missile fire-control system (MFCS)

The Mk 74 acquires, tracks and illuminates targets assigned to it by the weapon direction system. It operates with a missile handling/launching system but is not involved in the launch, sequence, which is controlled by the WDS. After missile launching the Mk 74 monitors the weapon and controls it until interception of the target then carries out a post-launch evaluation. The system consists of a computer system, an AN/SPG-51 G/H-I/J-band radar, a Mk 73 director and associated consoles. The system does not use a computer but a CV 3432 radar data processor, instead.

The SPG-51C radar uses a G/H-band pulse Doppler technique for automatic acquisition, tracking and missile guidance. Radar data readouts are displayed upon a dedicated radar console. The I/J-band CW illuminator is used as a reference beam in directing missiles and is detected by the missile's reference antennas as the signal antenna locks on to the energy reflected from the target. By comparing the target-reflected energy and missile rear reference energy it is possible to home the missile.

The SPG-51C radar has two independent channels each with a G/H-band tracking radar and an I/J-band illumination transmitter. This radar has longer detection and acquisition ranges than its predecessor, and automatic target scheduling, which require fewer operator decisions.

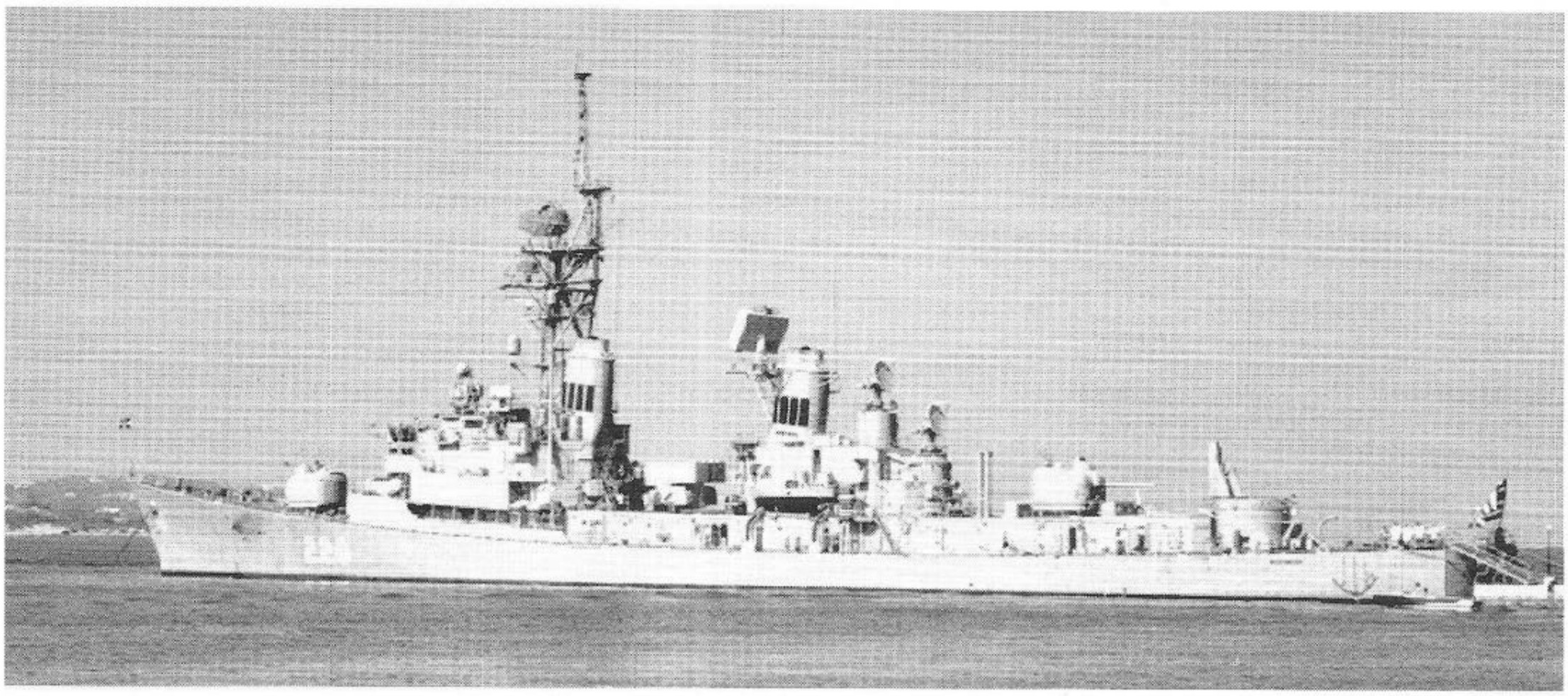
The Mk 73 director is a rotating electronic structure which includes the transmitter group, the control power supply for CW injection, the power supply for the pulse Doppler system, and a radar data converter. It can traverse up to 360° while elevation limits are −30 to +83°.

Manufacturer/Contractor

Raytheon Company, Equipment Division.

Mk 114 Anti-Submarine Fire-Control System

The Mk 114 is the fire-control system for ASW operations. The main element is the Mk 53 Attack Console, an electromechanical analogue system which consists of two major units, the attack plotter and the ballistic computer. The latter conducts weapon presets for both ASROC and ASW torpedoes. The Mk 114 system also includes the Mk 33 underwater fire-control switchboard which accepts data from two Mk 19 gyrocompasses and other sensors, as well as from the Mk 134 sonar stabilisation computer. The consoles have an AN/UYK-44 reconfigurable processor with some 70,000 lines of CMS-2 language code. The system interfaces with the sonar, in this case the bow-mounted Sangamo SQS-23D (SQQ-23 PAIR in D 219), which are being replaced by DE 1191.



Formion *(D 220)* (Paul Beaver)

Manufacturer/Contractor
Loral Librascope.

AN/SYS-1 data fusion system
The role of the AN/SYS-1 IADT (Integrated Automatic Detection and Tracking) system is to increase the number of air and surface targets which may be detected and tracked in all types of electronic environments by fusing them into one system. The system accepts contacts from each radar, seeks potential targets, correlates the data by comparing all the sensors' returns and then produces a single file of valid tracks, while avoiding duplication. The different radar characteristics provide an overlapping volume of coverage in a variety of clutter and ECM environments which may be monitored to obtain the best possible search coverage. The data is then fed to the ship's command and weapon control systems, and accepts inputs from fire-control radars.

Each system consists of two 16-bit Paramax AN/UYK-20 computers and two display consoles.

Manufacturer/Contractor
Norden Systems, Melville, New York, USA.

RADARS

Set	AN/SPS-52C	AN/SPS-40B/D	AN/SPS-10D/F	LN 66	AN/SPG-53A	AN/SPG-51D
Company	Hughes	Lockheed	Raytheon	Canadian Marconi	Western Electric	Raytheon
Role	Long-range air search	Surface search	Surface search	Navigation	Gun fire control	Missile fire control (SAM)
Band	E/F	E/F	G	I	G/I	G/I
Range	240 n miles (440 km)	175 n miles (320 km)	—	—	—	—
Beam	1.1 × 2.25°	11 × 19°	1.5 × 16°	2.5 × 22°	1.6°	Track: 1.6° Illum: 0.9°
Peak power	1,000 kW	200 kW	500 kW	75 kW	250 kW	Track: 81 kW Illum: 5 kW
Gain	39.5 db	21 dB	30 dB	30 dB	39 dB	Track: 39.5 dB Illum: 45 dB
Pulsewidth	2.5/4.6/10 µs	60 µs	0.25-1.3 µs	1.0/0.1 µs	0.25 µs	Track: 2.1-3.2 µs
PRF	1,850/925 pps	300 pps	625/650 pps	500/2,000 pps	1,000 pps	Surface: 4.1 kHz Air: 9.5-16.7 kHz
Scan rate	15/6 rpm	7.5/15 rpm	15 rpm	22 rpm	—	—

SONARS

All four ships are currently fitted with the US sonar equipment which was installed at the time of sale: Sangamo SQS 23D in D 218, D 220 and D 221; Sangamo SQQ-23 in D 219. All four sets are, however, being replaced by the Raytheon DE 1191.

Sangamo AN/SQS-23D
AN/SQS-23D is fitted in D 218, D 220 and D 221. SQS-23D dates from 1958 and is a bow-mounted, active, search and attack sonar, operating at medium frequency. Pulse lengths are 2-5, 30 and 120 ms, with base frequencies of 4.5, 5.0 and 5.5 kHz, which can be varied by ±380 Hz to reduce inter-ship interference. Typically, the system has an output of 60 kW while tracking, and a range of some 6 n miles (11 km). The Australian ships use solid-state electronics, which requires three cabinets, in place of the previous vacuum-tube versions' 21 cabinets. The sonar has limited bottom bounce capability.

Sangamo AN/SQQ-23A PAIR
Nearchos (D 219) is fitted with AN/SQQ-23QA PAIR (Performance And Integration Refit), which was installed while the ship was serving with the US Navy. Based on AN/SQS-23, AN/SQQ-23A has two (instead of one) domes, one in the bows, the second 18 m (60 ft) down the keel; the addition of an extra dome provides a triangulation baseline for distance measurement. SQQ-23 also uses PADLOC (passive/active detection and localisation). Because of the second sonar dome, *Nearchos* is fitted with a stern anchor.

PROPULSION

Specification
System: Steam turbines
Main machinery: D 219, D 221 — 4 Foster-Wheeler boilers; 2 Westinghouse turbines; D 218, D 220 — 4 Combustion Engineering boilers. All — 2 General Electric turbines; 52.2 MW (70,000 hp)
Shafts: 2

FURTHER INFORMATION

PROGRAMME

These ships are the only four units to have been sold to a foreign navy when the 23-strong class was paid off by the US Navy between 1989 and 1992. The four ships were leased by the Greek Navy under the provisions of the Defence Co-operation Agreement signed with the USA on 8 July 1990. The first to transfer, *Kimon,* recommissioned into the Greek Navy at Salamis in September 1992, while the other three transferred in San Diego and were commissioned on arrival in Greece on 1 October 1992. The Greek Navy subsequently acquired a fifth unit, the ex-*Richard E Byrd* (DDG 23), which was towed to Salamis on 12 October 1993 where it is used for training and as a source of spares.

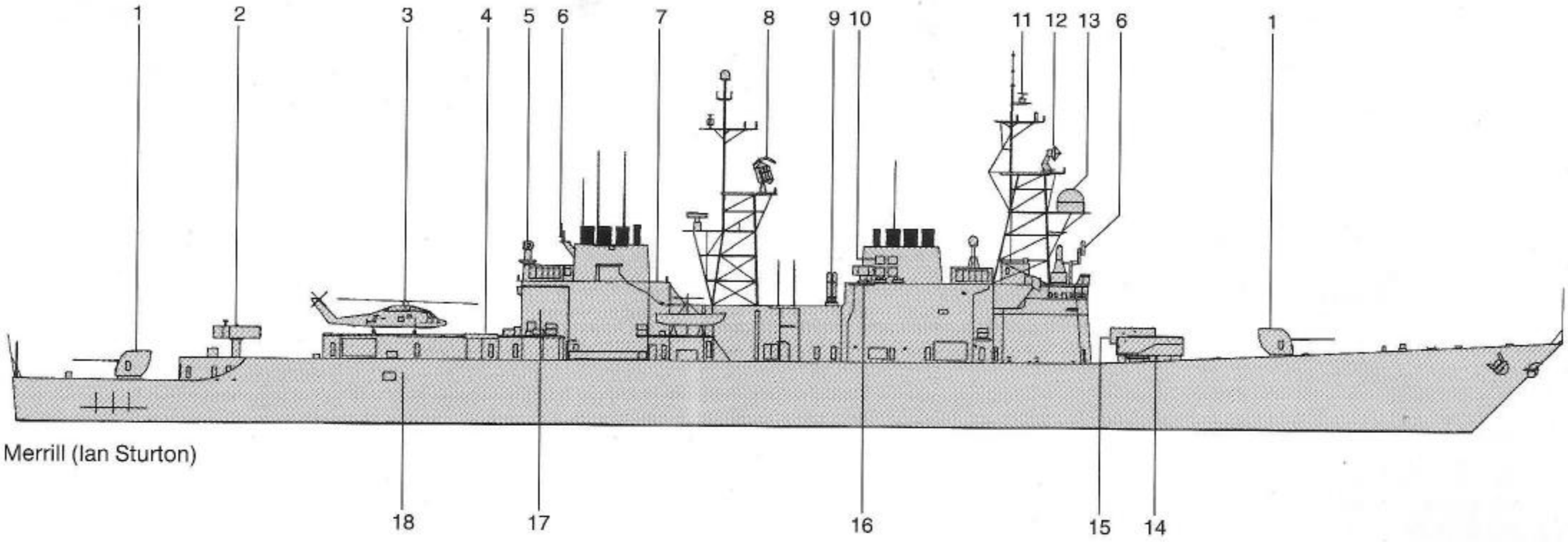
MODERNISATION

DE 1191 sonars and a Signaal STACOS command system are being fitted.

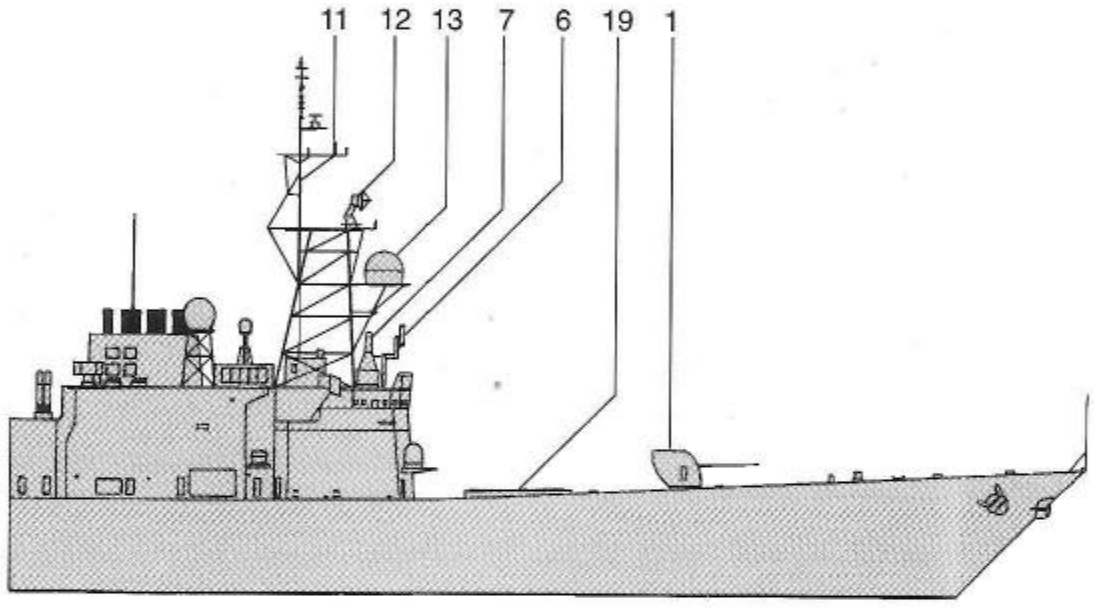
DESIGN

The ships are generally identical, except that *Nearchos* has a stern anchor, which was installed because of the AN/SQQ-23 (PAIR) arrangement (see 'Sonar' above).

SPRUANCE



Merrill (Ian Sturton)



Spruance (Ian Sturton)

1 127 mm (5 in/54) Mk 45 Mod 0/1 gun 2 GMLS Mk 29 octuple launcher for Sea Sparrow SAM 3 SH-60B LAMPS-III helicopter 4 Flight deck 5 Mk 95 radar (SAM) 6 Satcom SRR-1 7 Mk 15 Vulcan Phalanx (on hangar roof behind stack) 8 SPS-40 radar (air search) 9 Harpoon SSM launcher 10 SRBOC Mk 36 flare launcher 11 SPS-55 radar (surface search) 12 SPG-50 radar (fire control) 13 SPQ-9A radar (fire control) 14 Tomahawk box launcher 15 ASROC Mk 16 octuple launcher 16 SLQ-32(V)2 17 Hangar 18 Triple Mk 32 324 mm torpedo tubes (behind shutter) 19 Mk 41 Mod 0 vertical launch system

GENERAL SPECIFICATIONS

Operator: USA

Class: SPRUANCE

Built: 31
Active: 31

Displacement:
standard: 5,770 t
full load: 8,040 t

Dimensions
Length: 171.7 m (563.2 ft)
Beam: 16.8 m (55.1 ft)

Draught: 5.8 m (19 ft); 8.8 m (29 ft) (sonar)

Speed: 33 kts
Range: 6,000 n miles at 20 kts

Complement: 319-339 (20 officers)

SHIPS

SPRUANCE (DD 963)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 17 Nov 1972
Launched 10 Nov 1973
Commissioned 20 Sep 1975

PAUL F FOSTER (DD 964)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 6 Feb 1973
Launched 23 Feb 1974
Commissioned 21 Feb 1976

KINKAID (DD 965)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 19 Apr 1973
Launched 25 May 1974
Commissioned 10 Jul 1976

HEWITT (DD 966)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 23 Jul 1973
Launched 24 Aug 1974
Commissioned 25 Sep 1976

ELLIOTT (DD 967)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 15 Oct 1973
Launched 19 Dec 1974
Commissioned 22 Jan 1976

ARTHUR W RADFORD (DD 968)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 14 Jan 1974
Launched 1 Mar 1975
Commissioned 16 Apr 1977

PETERSON (DD 969)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 29 Apr 1974
Launched 21 Jun 1975
Commissioned 9 Jul 1977

CARON (DD 970)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 1 Jul 1974
Launched 24 Jun 1975
Commissioned 1 Oct 1977

DAVID R RAY (DD 971)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 23 Sep 1974
Launched 23 Aug 1975
Commissioned 19 Nov 1977

OLDENDORF (DD 972)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 27 Dec 1974
Launched 21 Oct 1975
Commissioned 4 Mar 1978

JOHN YOUNG (DD 973)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 17 Feb 1975
Launched 7 Feb 1976
Commissioned 20 May 1978

COMTE DE GRASSE (DD 974)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 4 Apr 1975
Launched 26 Mar 1976
Commissioned 5 Aug 1978

O'BRIEN (DD 975)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 9 May 1975
Launched 8 Jul 1976
Commissioned 3 Dec 1977

MERRILL (DD 976)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 16 Jun 1975
Launched 1 Sep 1976
Commissioned 11 Mar 1978

BRISCOE (DD 977)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 21 Jul 1975
Launched 15 Dec 1976
Commissioned 3 Jun 1978

STUMP (DD 978)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 25 Aug 1975
Launched 29 Jan 1977
Commissioned 19 Aug 1978

CONOLLY (DD 979)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 29 Sep 1975
Launched 19 Feb 1977
Commissioned 14 Oct 1978

MOOSBRUGGER (DD 980)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 3 Nov 1975
Launched 23 Jul 1977
Commissioned 16 Dec 1978

JOHN HANCOCK (DD 981)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 16 Jan 1976
Launched 29 Oct 1977
Commissioned 1 Mar 1979

NICHOLSON (DD 982)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 20 Feb 1976
Launched 11 Nov 1977
Commissioned 12 May 1979

JOHN RODGERS (DD 983)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 12 Aug 1976
Launched 25 Feb 1978
Commissioned 14 Jul 1979

LEFTWICH (DD 984)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 12 Nov 1976
Launched 8 Apr 1978
Commissioned 25 Aug 1979

CUSHING (DD 985)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 27 Dec 1976
Launched 17 Jun 1978
Commissioned 21 Sep 1979

HARRY W HILL (DD 986)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 3 Jan 1977
Launched 10 Aug 1978
Commissioned 17 Nov 1979

O'BANNON (DD 987)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 21 Feb 1977
Launched 25 Sep 1978
Commissioned 15 Dec 1979

THORN (DD 988)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 29 Aug 1977
Launched 14 Nov 1978
Commissioned 16 Feb 1980

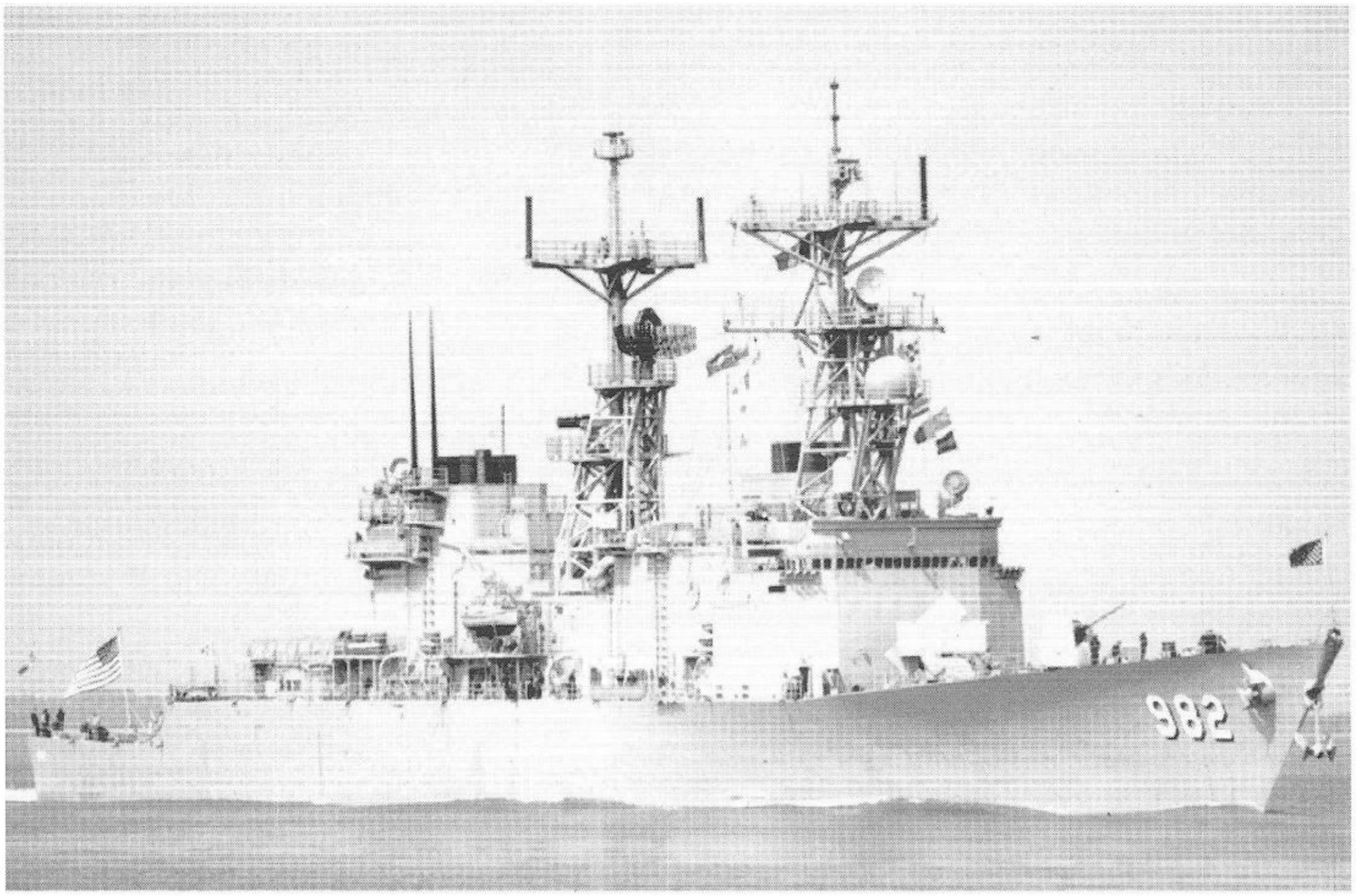
DEYO (DD 989)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 14 Oct 1977
Launched 27 Jan 1979
Commissioned 22 Mar 1980

INGERSOLL (DD 990)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 5 Dec 1977
Launched 10 Mar 1979
Commissioned 12 Apr 1980

FIFE (DD 991)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 6 Mar 1978
Launched 1 May 1979
Commissioned 31 May 1980

FLETCHER (DD 992)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 24 Apr 1978
Launched 16 Jun 1979
Commissioned 12 Jul 1980

HAYLER (DD 997)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 20 Oct 1980
Launched 27 Mar 1982
Commissioned 5 Mar 1983



Nicholson *(DD 982) with the Mk 16 launcher trained to port and one section raised. On the bridge roof are a single Mk 15 Phalanx CIWS (left — white thimble radome) and a satellite communications antenna (right). On the foremast is the large 'football' radome for the SPQ-9A and the circular dish of the SPG-60; both are elements of the Mk 86 fire-control system* (H & L van Ginderen Collection)

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

BGM-109 Tomahawk

All ships are fitted with Tomahawk:

DD 974, 976, 979, 983-984, 989-990 have eight missiles in two Mk 44 armoured box launchers

Remaining ships are fitted with the Mk 41 Mod 0 vertical launch system (VLS).

Any version of Tomahawk can be carried, two of which are for land-attack missions, one with a conventional HE warhead (BGM-109C Tomahawk Land Attack Missile — Conventional (TLAM-C)) and the other with submunitions (BGM-109D Tomahawk Land Attack Missile — D (TLAM-D)). The third type is the BGM-109B Tomahawk Anti-Ship Missile (TASM), which also has a conventional HE warhead. A fourth version, BGM-109A Tomahawk Land Attack Missile-Nuclear (TLAM-N), has been removed from ships at sea but is retained in reserve ashore and the ships could quickly be recertified for TLAM-N in an emergency.

The major sub-type now in service is the Block II, although the Block III has been in production since 1993 and Block II missiles are being progressively brought up to the new standard. The missile is launched using a rocket booster until the turbofan engine takes over and the booster is jettisoned.

BGM-109A uses inertial navigation with terrain contour matching (Tercom), while BGM-109B uses inertial plus active radar terminal guidance, and BGM-109C/D inertial and Tercom mid-course guidance with Digital Scene Matching Area Correlation (DSMAC) for terminal guidance. Tercom stores digital terrain profile map information in the missile before launch, which is compared with radar altimeter measurements of ground elevations below the missile during a set number of sections en route to the target. The Block III upgrade programme includes a Global Positioning System (GPS) receiver to supplement or replace the Tercom system. In the terminal phase, DSMAC compares a stored digital representation of the target area with the scene viewed below the missile by a TV camera. This latter system is claimed to be extremely accurate for attacking land targets, with a circular error probable (CEP) of 10 m being reported. Both the BGM-109C and D versions have a programmable terminal dive attack mode option.

The BGM-109A is fitted with a W80 135 kg (298 lb) nuclear warhead, while the BGM-109B/C have 454 kg (1,000 lb) unitary HE warheads taken from old Bullpup B missiles. The BGM-109D has 166 combined effects BLU-97B bomblets, each weighing 1.5 kg (3.3 lb) which can be dispensed in groups against up to four separate targets.

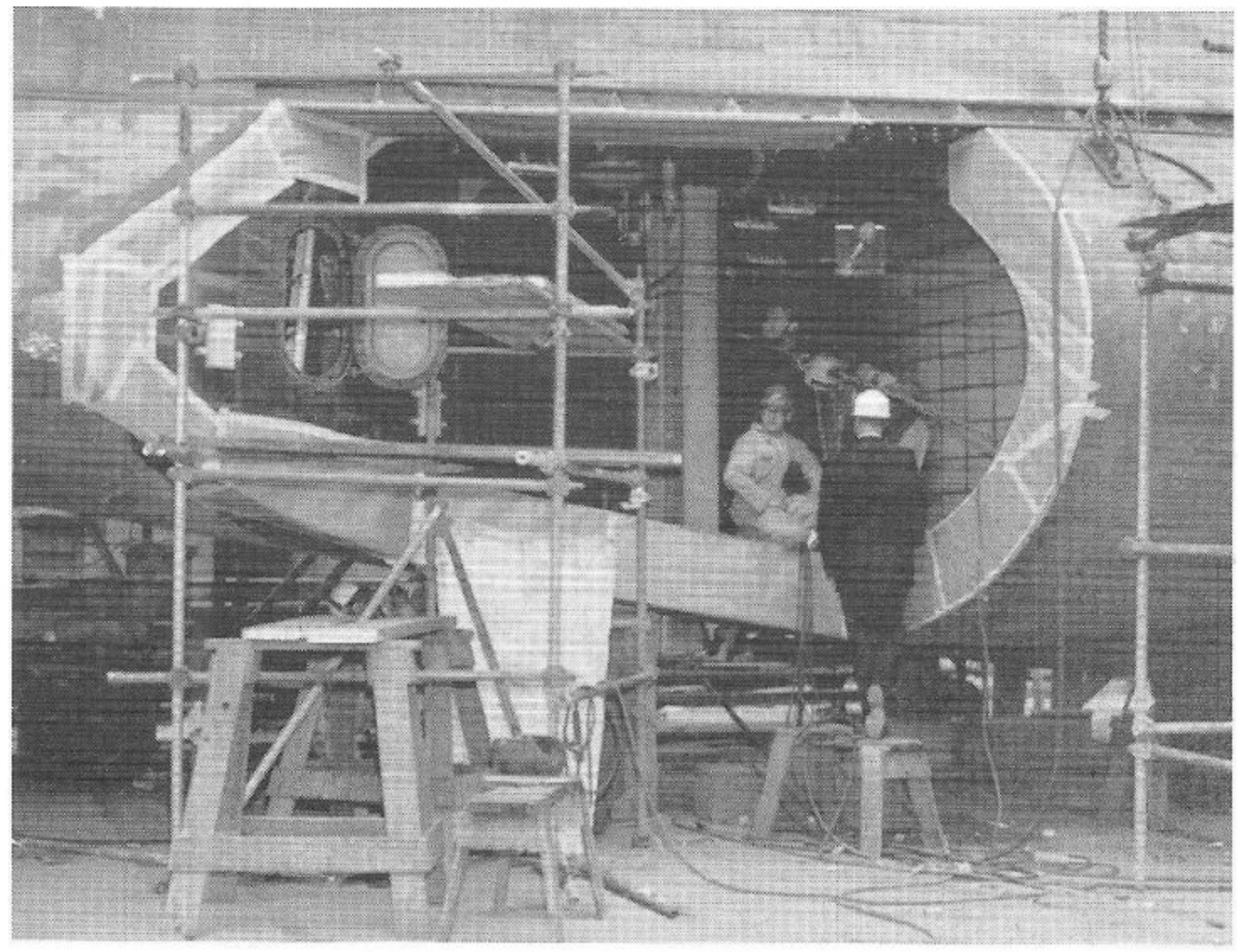
Block III missiles have a more powerful and more fuel-efficient turbofan engine, which, coupled with increased fuel capacity, results in a range increase of at least 30 per cent. The BGM-109C Block 3 missiles have a smaller WDU-36B 320 kg (700 lb) warhead carrying a unitary HE charge with a selectable fuze delay to increase warhead penetration before detonation.

Specifications

Designation	BGM-109B (Note 1)	BGM-109C Block II	BGM-109C Block III	BGM-109D Block II
Mission	Tomahawk anti-ship missile (TASM)	Tomahawk land-attack missile — conventional (TLAM-C)	Tomahawk land-attack missile — conventional (TLAM-C)	Tomahawk land-attack missile — D (TLAM-D)
Airframe standard	Block II	Block II	Block III	Block II
Length	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)
Diameter	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)
Wing span	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)
Launch weight	1,452 kg (3,201 lb)	1,452 kg (3,201 lb)	n/k	1,452 kg (3,201 lb)
Warheads	454 kg HE (1,000 lb)	454 kg HE (1,000 lb)	320 kg (705 lb)	166 bomblets
Range	240 n miles (450 km)	490-700 n miles (900-1,300 km)	1000 n miles (1,857 km)	490 n miles (900 km)
Accuracy — circular error probable (cep)	n/a	10 m (33 ft)	10 m (33 ft)	10 m (33 ft)
Speed	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)
In-service date	1983	1983	1993	1989
Engine	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR402 turbofan (335 kg thrust)	Williams International F107-WR400 turbofan (272 kg thrust)
Number currently on order	593	1,486		1,157

Notes

1. BGM-109A (TLAM-N) is not listed as it is not deployed in operational ships, but it should be noted that it remains in reserve ashore.



Bow dome cutaway showing partial view of AN/SQS-53 cylindrical transducer

Manufacturers/Contractors

Hughes Missile Systems, Tucson, Arizona, USA (prime).

McDonnell Douglas Missile Systems, St Louis, Missouri, USA (second source).

McDonnell Douglas UGM-84B Harpoon

Eight Harpoon anti-ship missile canisters are mounted immediately aft of the forward stack. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

These three pictures show the major differences in armament. Harry W Hill *(DD 986) (top) shows the original Mk 16 ASROC octuple launcher. In the centre,* Deyo *(DD 989), has the Mk 16 ASROC launcher plus the Mk 44 quadruple box launchers. The bottom picture,* Paul F Foster *(DD 964) shows the modernised standard with a Mk 41 vertical launch system containing a mix of Tomahawk and ASROC* (DD 986, DD 964: H & L van Ginderen Collection/DD 964: US DoD)

Specifications
(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors
McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warfare).
Thiokol, Elkton, Maryland, USA (booster).

SURFACE-TO-AIR MISSILES (SAM)

Raytheon Sea Sparrow point-defence missile system
One GMLS Mk 29 octuple launcher is installed aft, between the flight deck and the after gun. The magazine contains 24 RIM-7 Sea Sparrow missiles. The system is fully automatic from target acquisition to interception. The Sea Sparrow missile, although based upon the air-to-air Sparrow, has been enhanced for launching from ships, and has a 38.6 kg blast fragmentation warhead and a dual-purpose proximity impact fuze.

Specifications
(RIM-7M)
Length: 3.66 m (12.0 ft)
Diameter: 20.3 cm (8.0 in)
Wing span: 1.02 m (3.35 ft)
Weight: 226.8 kg (500 lb)
Speed: Mach 2.5
Range: 8 n miles (14.5 km)
Warhead (WAU-17/B): 38.6 kg (85.1 lb)
Guidance: Semi-active radar

Manufacturers/Contractors
Raytheon Company, Missile Systems Division (prime missile contractor).
Hughes Missile Systems (second missile source).
Naval Weapons Center, Crane, USA (warhead).

RIM-116A RAM close in system
The Rolling-Airframe Missile (RAM) system is being installed in all ships of the class from 1994 onwards. The launcher is sited on the starboard side, right aft. RAM is a lightweight, close in, quick reaction, anti-ship missile defence system. The missile itself, designated RIM-116, is based on the Sidewinder air-to-air missile, but with significant modifications, enabling it to be used as a fire-and-forget system. There is an infra-red, terminal guidance seeker in the nose (taken from the Stinger manportable surface-to-air missile), behind which is a new dual-mode passive radio frequency seeker for mid-course guidance. Most of the rear of the missile is based upon Sidewinder components.

Missiles are stored in sealed launcher containers, which are manually loaded into the 21-cell Mk 49 RAM Standard Launcher. This is mounted on the same base as that used by the Phalanx and retains that system's elevation and train drive assemblies.

Radar and electro-optical sensors provide details of target location, distance and speed, while the ship's ESM system inputs data on the target's radar frequency, as well as correlating radar data on location. On launch, the missile is spun-up by a rifling band as it is driven down the launch tube, and then as it leaves the launcher the four tail fins deploy which maintains the spin. Aerodynamic control is provided by the two canard surfaces, which also deploy after launch. The

autopilot and control system maintain the initial line-of-sight course towards the target and then the RF seeker is activated and once this acquires the target it takes control of the guidance system and makes the appropriate course alterations. The IR seeker is also activated and when a sufficient signal-to-noise ratio is achieved this takes over guidance control for the terminal phase. The missile is capable of manoeuvres up to 20 *g* in any direction.

Specifications

Mk 49 RAM Standard launcher
Traverse: 360°
Elevation: –25 to +80°
Turning circle: 3.27 m (10.73 ft)

RIM-116 missile
Length: 2.79 m (9.15 ft)
Diameter: 12.7 cm (5 in)
Wing span: 43.4 cm (17.1 in)
Weight: 73.6 kg (162.25 lb)
Speed: Mach 2
Range: 5.17 n miles (9.6 km)
Warhead: 9.09 kg (20 lb) fragmentation blast (WDU-17B)
Motor: Hercules/Aerojet Mk 36 solid propellant rocket

Manufacturers/Contractors

Hughes Missile Systems, Tucson Arizona, USA.
RAM Systems GmbH, Europe.

Sikorsky SH-60B LAMPS-III helicopter landing on a 'Spruance' class destroyer. The LAMPS-III system links the helicopter into the SQQ-89(V) ASW system via the SQQ-28 datalink (Sikorsky)

ANTI-SUBMARINE MISSILES

Honeywell RUR-5A ASROC

ASROC consists of a Mk 46 torpedo with strap-on aerodynamic surfaces and a rocket motor to enable it to fly to within range of its submarine target. Attached to the rear end of the torpedo is a short airframe assembly of clam-like construction, held together by a steel band, with a Naval Propulsion Plant solid propellant booster and four trapezoidal aerodynamic surfaces to provide stability in flight. Payload is an Alliant Mk 46 Mod 5 torpedo, which has a seeker designed specifically to detect most types of target, including submarines with anechoically coated hulls, and has an estimated acquisition range of 460 m (1,500 ft).

When the ship sensors detect a submarine target it is tracked and the attack console's fire-control computer predicts the target's position. The launcher is turned in the appropriate direction and elevated to an angle appropriate to the range. The fire-control computer then orders the launch and the booster burns for a programmed time of between 1 and 4 seconds, by which time the missile will have reached a height of between 60 (200 ft) and 305 m (1,000 ft), although the aerodynamically stable airframe enables it to coast up to 600 m (2,000 ft). On reaching the programmed position, an explosive bolt cuts the steel band holding the airframe assembly sections together and, as they separate, the parachute deploys to retard the torpedo's fall, water entry taking place some 14 to 50 seconds after launch. As the torpedo enters the water the frangible nose cap breaks off and the torpedo begins its search for the target using a predetermined pattern.

Tomahawk at launch from a Mk 44 four-cell, box launcher (US Navy)

Specifications

ASROC missile
Length: 4.6 m (15.1 ft)
Diameter: 32.5 cm (12.8 in)
Span: 84.5 cm (33.3 in)
Weight: 435 kg (959 lb)
Range:
Mk 116 launcher: 0.86-5.39 n miles (1.6-10 km)
VLS ASROC: 9 n miles (16.6 km)
Speed: Mach 0.9

	Mk 46 Mod 5	Mk 50
Diameter	324 mm (12.75 in)	324 mm (12.75 in)
Length	2.95 m (9.68 ft)	2.89 m (9.48 ft)
Weight	230 kg (507 lb)	363 kg (800 lb)
Speed	40 kts	55-60 kts
Range	6 n miles (11.2 km)	10.75 n miles (20 km)
Homing	Active/passive acoustic homing	
Warhead	Mk 103 Mod 1; 44 kg; PBXN-103	45 kg shaped charge HE
Motor	5-cylinder liquid mono-propellant (Otto) motor	closed-cycle

Manufacturers/Contractors

Honeywell Training and Control Systems, West Covina, California — Mk 46.
Alliant TechSystems Inc, Marine Systems — Mk 50.
Westinghouse Electronic Corporation, Naval Systems Division.

TORPEDOES

324 mm Mk 32 triple torpedo launchers

Two triple 32 torpedo launchers are mounted, one on either beam, inside the superstructure below the flight deck. This protects them from the elements, enables them to use a central magazine and also facilitates

maintenance. A shutter is raised to enable the tubes to fire.

Honeywell Mk 46 or Alliant/Westinghouse Mk 50 torpedoes

The ship carries 14 torpedoes; either Honeywell Mk 46 or Alliant/Westinghouse Mk 50 (see ASROC above for details)

GUNS

Mk 45 Mod 0/1 single 127 mm (5 in) L/54 gun mounting

Two single 127 mm Mk 45 Mod 0/1 guns are mounted, one forward, the second aft. The weapon fires semi-fixed ammunition with point detonating, proximity (variable time or infra-red), mechanical time and electronically set fuzes. The theoretical rate of fire is 20 rds/min and a gun crew of six is required, all below decks, of which four are ammunition handlers. The Mod 1 incorporates a number of improvements, including the ability to change the type of ammunition under remote control and electronic fuze setting.

The Semi-Active Laser-Guided Projectile (SALGP) Prototype Mod 3 will start trials in 1998. This shell has a range of 20 n miles (37 km).

Specifications

Calibre: 127 mm (5 in)
Length of barrel: 54 calibres
Muzzle velocity: 807.72 m/s (new barrel), 762 m/s (mid-life)
Crew: 6 (1 mount captain, 1 panel operator, 4 ammunition handlers)
Traverse: 340° at 30°/s
Elevation: −15 to +65° at 20°/s
Range:
- **anti-ship:** 12.39 n miles (23 km)
- **anti-air:** 15,000 m (49,000 ft)

Rate of fire: 16-20 rds/min
Ammunition weight: 31.75 kg (projectile)

Manufacturer/Contractor

United Defense, Armament Systems Division, Minneapolis, Minnesota, USA.

Hughes Mk 15 CIWS Phalanx

Two Hughes Mk 15 Phalanx close in weapons systems (CIWS) provide the innermost layer of defence against anti-ship missiles. One mount is located on the bridge roof (starboard side), the other on the hangar roof (port side). Each mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n miles (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications

Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor

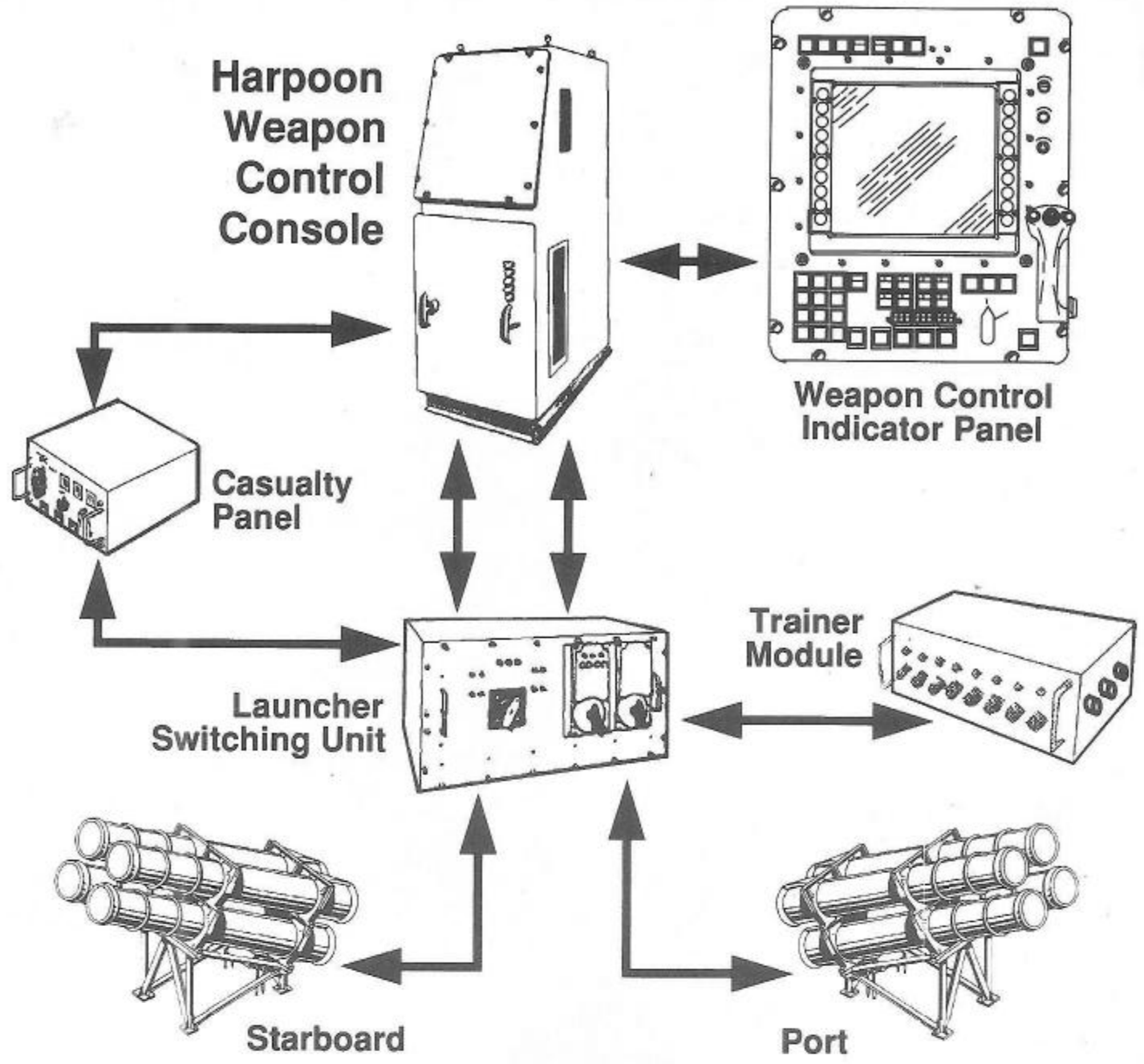
Hughes Missile Systems, Tucson, Arizona, USA (system).

Machine guns

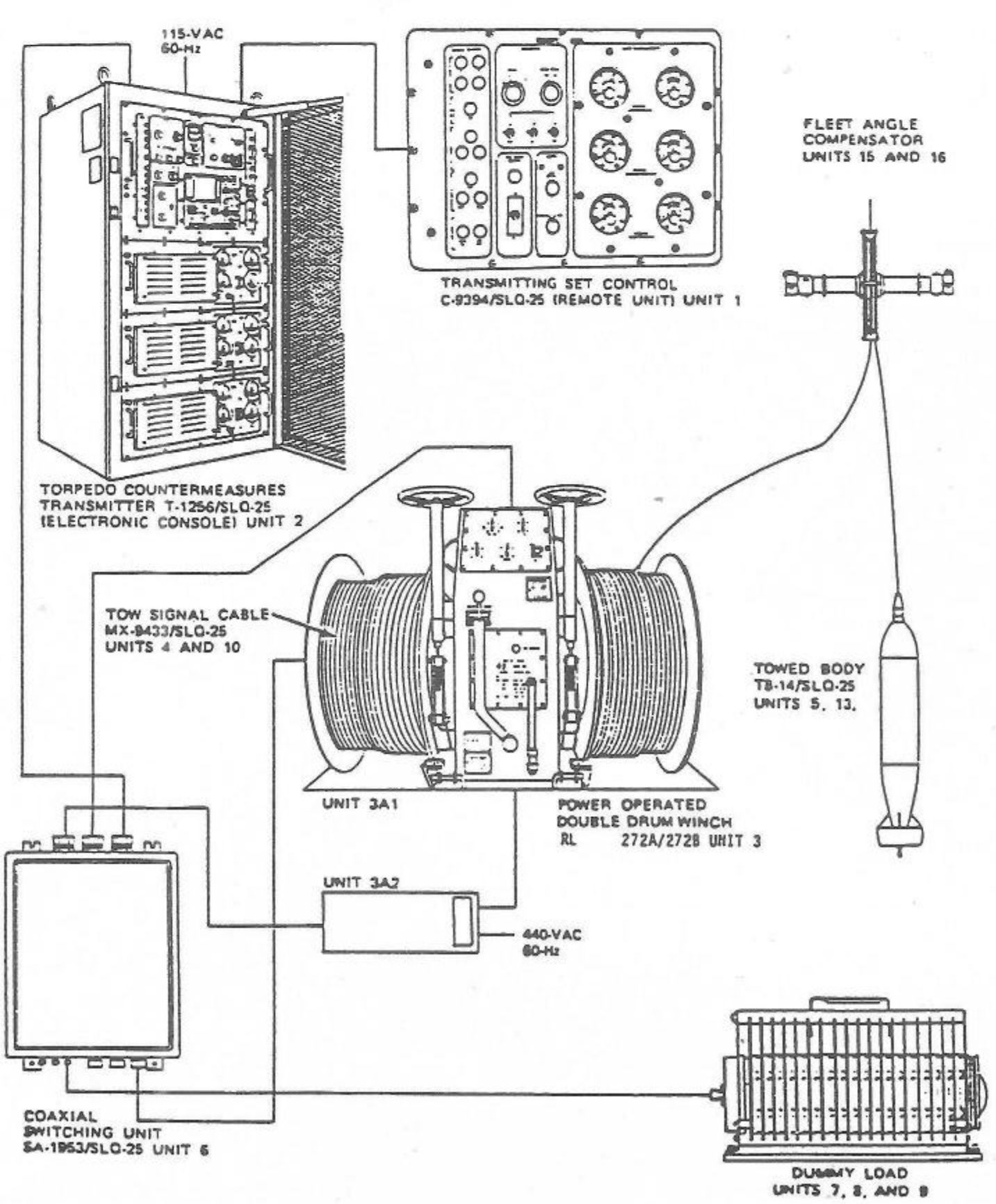
Four 12.7 mm (0.50 in) M2 machine guns.

Specifications

Calibre: 12.7 mm (0.50 in)
Rate of fire: 450-550 rds/min
Muzzle velocity: 883 m/s (2,900 ft/s)
Max effective range:
- **anti-surface:** 6,700 m (7,400 yd)
- **anti-air:** 1,380 m (4,500 ft)



Components of the SWG-1A launch control system


115-VAC 60-Hz
TRANSMITTING SET CONTROL C-9394/SLQ-25 (REMOTE UNIT) UNIT 1
FLEET ANGLE COMPENSATOR UNITS 15 AND 16
TORPEDO COUNTERMEASURES TRANSMITTER T-1256/SLQ-25 (ELECTRONIC CONSOLE) UNIT 2
TOW SIGNAL CABLE MX-9433/SLQ-25 UNITS 4 AND 10
TOWED BODY TB-14/SLQ-25 UNITS 5, 13,
UNIT 3A1
POWER OPERATED DOUBLE DRUM WINCH RL 272A/272B UNIT 3
UNIT 3A2
440-VAC 60-Hz
COAXIAL SWITCHING UNIT SA-1953/SLQ-25 UNIT 6
DUMMY LOAD UNITS 7, 8, AND 9

NIXIE noisemaker components

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

AN/SLQ-32(V)5 Sidekick ESM Suite

As built, all ships had AN/SLQ-32(V)2 EW suite, but most now have had this upgraded to (V)5 standard suite, previous plans of upgrading to AN/SLQ-32(V)3 having been discarded. AN/SLQ-32(V)2 is an ESM system, giving radar warning across the B- to H-bands, while the addition of Raytheon's Sidekick adds an ECM capability. Some ships were fitted with WLR-1 as a temporary measure, but were upgraded to AN/SLQ-32(V)2 as the equipment became available.

Manufacturer/Contractor

Raytheon Company, Electromagnetic Systems Division, Goleta, California.

AN/SSQ-108(V)2 OUTBOARD II shipborne countermeasures detection and analysis system

The AN/SSQ-108(V)2 system (also known as OUTBOARD II) is designed to provide real-time technical and tactical intelligence data to enable the force commander to analyse enemy dispositions and intentions for Over-The-Horizon (OTH) detection and identification of surface ships for targeting purposes. The elements of AN/SSQ-108(V)2 OUTBOARD II are:

- SRD-19A, which consists of a masthead VHF direction-finding group of Adcock-type arrays and 24 deck-edge antennas in three groups of eight, which are electronically switched to form receiving beams
- SLR-16A countermeasures receiver
- OK-324/SYQ System Supervisor Station (SSS), including a modification kit to upgrade it from the SSQ-108(V)1
- the SLR-23 automated narrowband acquisition system
- a local monitoring station and tactical intelligence communications.

The OK-324/SYQ SSS integrates and controls OUTBOARD sensors as well as external datalinks and communication to provide information processing and technical dissemination. The system uses hull and mast-mounted antenna arrays. The system has been fitted in about 36 destroyers and cruisers to provide signals intelligence, early warning and OTH capabilities to surface ships that accompany each US Navy carrier force.

Manufacturer/Contractor

Lockheed Sanders Inc, Nashua, New Hampshire, USA.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher

There are four Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units, with two pairs mounted on small platforms either side of the forward stack.

Specifications

Launcher
Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Rounds
Mk 182: 1,209 × 130 mm; 22.7 kg
Super Chaffstar: 1,209 × 130 mm; 20.9 kg
Super Gemini: 451 × 130 mm; 5.5 kg
Super Hiram III: 1,220 × 130 mm; 13.6 kg
Super Hiram IV: 467 × 130 mm; 3.8 kg
Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturers/Contractors

Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

AN/SLQ-39

SLQ-39 is a chaff-dispensing buoy.

AN/SLQ-25 Nixie noisemaker

The AN/SLQ-25 Nixie is a solid-state, modular design electro-acoustic countermeasures decoy system used to protect the carrier from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 487.5 m (1,600 ft) of cable at 30.5 m/min (100 ft), each cable weighing 408.24 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 94.6 cm (37 in) long, 15.24 cm (6 in) in diameter and weigh 18.14 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body at a time is deployed.

Manufacturer/Contractor

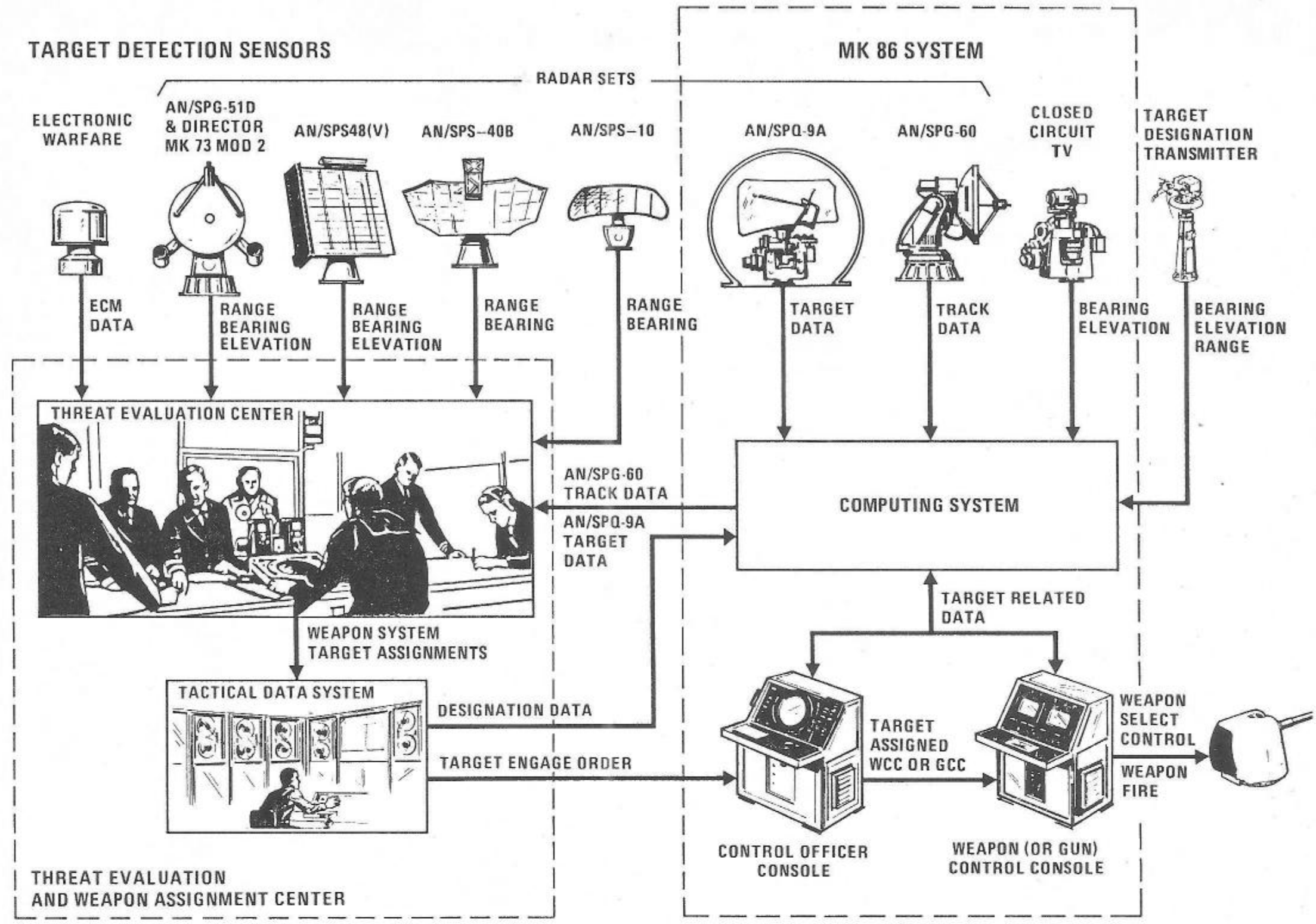
Aerojet ElectroSystems, Sacramento, USA.

Masker/Prairie Masker noise suppression systems

The ships are fitted with both Masker and Prairie-Masker radiated noise suppression systems. In Masker, high-pressure air is bled off from either the ship's gas-turbine or dedicated compressors and ejected from a pipe placed laterally across the ship's hull just forward of the machinery spaces. The forward motion of the ship causes the air to form a layer separating the hull from the water and thus masking the machinery noises which would otherwise be radiated directly into the water. Such a system is less effective at slow speeds where the air bubbles tend to rise to the surface rather than remain attached to the hull.

In Prairie Masker, air is passed down the propeller shaft and ejected from a groove in the leading edge of the blade, thus delaying the onset of cavitation.

Deyo *(DD 989) rides steadily during the 1993 Battle of the Atlantic Review* (H & L van Ginderen Collection)



Mk 86 Gun Fire Control System (within broken line)

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS AND DATALINKS

Link 11
Link 14
SRR-1 Satcom
WSC-3 (UHF) Satcom
USC-38 (EHF) Satcom (in some)
SQQ-28 for LAMPS datalink.

WEAPONS CONTROL

AN/SWG-1A Harpoon Launch Control System (LCS)

The SWG-1A Harpoon Launch Control System activates the missile, selects the flight pattern and sets seeker search modes (with small, medium or large acquisition windows), as well as providing target range and bearing data. Alternatively, the missile can simply be launched along the bearing of the target, with the seeker activated early to scan a 90° sector; if, after a set time, no target has been acquired, the missile commences a preset search pattern. SWG-1A takes account of other ships in the general target area and generates indirect flight plans for the missile, including waypoints to optimise angles of approach which will achieve the highest possibility of success while minimising the chances of the missile being destroyed by hostile fire. It can also be used to compute flight plans in a multiple attack so that several missiles, from either the same or different ships, arrive on target simultaneously, thus swamping the defences.

SWG-3 Tomahawk WCS

SWG-3 is the weapon control system for the Tomahawk missile.

Gun Fire Control System (GFCS) Mk 86 Mod 3

GFCS Mk 86 controls direct and indirect naval gunfire support and also assists in the engagement of both surface and air targets. It has a mainframe architecture using CMS-2 software language and consists of a computer system, a display system and three sensors, and accepts data from ACDS, the Mk 74 fire-control system and optical Target Designation Transmitters. The Mk 86 Mod 3 system installed in the 'Spruance' class is configured to control the two 127 mm guns for defence against surface and air targets, and for shore bombardment. It uses two AN/UYK-7 32-bit computers, each with a memory of 256,000 words and an operating speed of 667,000 operations per second. The system can track 120 targets simultaneously.

The primary sensors are the AN/SPQ-9A and AN/SPG-60 fire-control radars for surface and air engagements respectively, as well as a remotely operated electro-optic tracker known as the Remote Optical Sight (ROS) of which there are usually two. Another electro-optical tracker (also designated an ROS) is attached to the AN/SPG-60 antenna mounting. Both radars are subject to improvement.

The AN/SPQ-9 is a high-resolution, track-while-scan, pulse compression I-band radar with a peak power of 1.2 kW and a PRF of 3,000 pps which has a basic capacity of four targets which may be expanded to more than 100. It provides detection and tracking facilities of surface targets at ranges between 135 m and 20 n miles (37 km) and limited air cover at altitudes up to 610 m. The radar operates in one of five selectable frequency ranges with pulse-to-pulse frequency agility. The system features a high scanning rate to provide a one second data rate, real-time signal and data processing, while an MTI facility has been developed to enhance sub-clutter visibility. The AN/SPG-60 is a four-horn amplitude-comparison monopulse I/J-band pulse Doppler radar which can acquire and track targets at ranges up to 100 n miles (185 km). The search-to-acquire capability is computer directed and the radar can accept 2D and 3D target designation coordinates in digital or synchro format. Tracking may be conducted automatically or manually. The radar can operate on a large number of different pulse repetition frequencies with up to six scanning patterns. The antenna includes an electro-optic sight (designated an ROS).

Targets acquired by the ship's search radars, missile fire-control radars and EW system are evaluated by the Combat Information Center (CIC) which designates them to the Mk 86 COC. They are then assigned to a WCC together with a gun or guns for acquisition and tracking which are monitored by the COC operator. The GCC/WCC operator checks the ballistic solution and commands the loading and firing of the gun or guns.

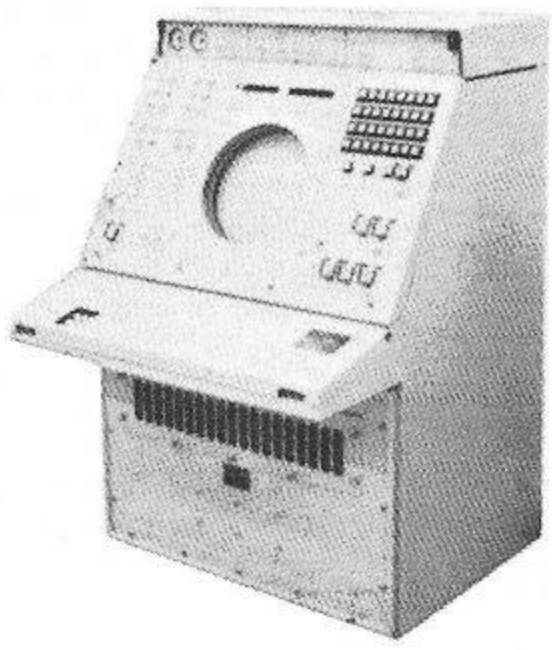
Several operational modes are available:

Radar Surface Fire. Upon target acquisition, a track-while-scan routine is used to track simultaneously multiple designated targets. Smoothed radar data with appropriate ballistics data, are used to compute weapon orders.

Air Action. The computer automatically and adaptively controls search patterns to acquire and track air targets. Target data, plus a TV view along the SPG-60 boresight axis, are displayed on a weapon control console. The engagement with SM-2 missiles is facilitated by virtue of continuous wave illumination injection to the SPG-60 tracking radar. A pre-action calibration of gun weapons can be initiated from the weapon control consoles.

Anti-Ship Missile Defense (ASMD). The track-while-scan acquisition gate is expanded to a range sufficient for threat detection. (Full 360° coverage, or coverage over a number of segments to provide surveillance of selected areas, can be chosen.) All targets passing through the acquisition gate are then automatically detected by the system. After target detection, the following functions are performed automatically: (a) threat evaluation (b) weapon assignment (c) assignment of targets to tracking channels (d) slewing of AA director and a weapon to the target (e) scan of AA director and 3D track of targets (f) initiation of firing; transfer of fire to second target.

Visual Surface Fire. A future facility will allow the weapon controller to track the target visually with the TV system and fire the laser to obtain range data. Target



The firing officer's console of the Mk 91 air defence fire-control system

range and angle data are entered into the system automatically, and ballistics are computed. Indirect shore bombardment for shore fire support missions or engagement of targets that are not within view of either radar or optical sensors, target and 'own ship' co-ordinates are entered at a weapon control console. The system automatically updates these with inputs from the ship's compass and log, or by means of a beacon or other navigational aids. Spotting data is entered at the keyboard. Automatic compensation for orientation of the target line by an on-shore observer is provided.

Manufacturer/Contractor

Lockheed Electronics Company Inc, Nashua, New Hampshire, USA.

Mk 91 Mod 2 (AN/SWY-1(V)) air defence fire-control system

The Mk 91 fire-control system can operate in either automatic or semi-automatic modes from target acquisition to interception. It is a mainframe system using an NFT (Norsk Forsvarsteknologi) Mk 157 digital computer which performs all necessary calculations, stores data and is responsible for data distribution.

The Mk 95 tracker-illuminator consists of a Mk 78 radar director with separate transmitting and receiving antennas, a director controller (Mk 106) and a low-light TV camera (Mk 6) with 2.4 × 2.4° and 10 × 10° fields-of-view. The I-band radar directs the missile to fly a lead angle course to the intercept point allowing Sea Sparrow-equipped ships to protect both themselves and other ships in company. Inboard equipment includes a Mk 73 continuous wave illuminator transmitter, a signal data processor (Mk 17), a signal data converter (Mk 80) and a director controller (Mk 106). There is a radar set console (Mk 83), with Bell Aerospace low-light television monitor and a firing officer's console (Mk 86).

Because of its I-band frequency the Mk 91 will detect sea-skimming missiles sooner than lower-frequency search radars; the system can thus be fully autonomous, conducting search, detection and engagement automatically. It can also accept outside designations from radar, EW or optic sources. Radar data from the director is passed to the signal data processor to provide range and angle tracking data. This data is passed to the firing officer's console from where pre-launch data and firing commands are relayed to the Mk 29 trainable launcher and missile. The launcher then trains in azimuth to the intercept point and in superelevation to optimum angle to maximise missile kinetic energy. Should the correct azimuth be blocked by the ship's superstructure, the launcher trains to the nearest clear azimuth and commands the missile to 'fly around the corner' to the direct path to the intercept. On launch, the missile flies a proportional navigation path (lead angle intercept) directly to the intercept point in a lofted trajectory which maximises energy and minimises image effects.

Manufacturer/Contractor

Raytheon Company, Equipment Division (prime).

RADARS

	SPS-40 B/C/D (not in DD 997)	SPS-49(V)7 (only in DD 997)	Mk 23 TAS	SPS-55	SPS-64(V)9 (being fitted)	SPG-60	SPQ-9A	Mk 95
Manufacturer	Lockheed	Raytheon	Hughes	Cardion	Raytheon	Lockheed	Lockheed	Raytheon
Role	Air search	Air search	Target acquisition	Surface search	Navigation	Fire control	Fire control	Fire control (for SAM)
Band	E/F	C/D (0.5-2 GHz)	D	I/J (8-20 GHz)	I	I/J	I/J	I/J
Beam	11 × 19°	3.4° × 30° csc²	3.3 × 75°	1.5 × 20°	1.9 × 22°	12 × 1.2°	1.35 × 3°	
Peak power	200 kW	360 kW	200 kW	130 kW	20 kW	5.5 kW	1.2 kW	2 kW
Gain	21 dB	28.5 dB	21 dB	31 dB	28 dB	41.5 dB	37 dB	
Pulsewidth	60 µs	125 µs/2 µs	—	1/12 µs	0.06/0.5/1.0 µs	0.27/1/6 µs	0.3-16 µs	
PRF	300 pps	280/800/1,000 pps	—	750/2,250 pps	3,600/1,800/900 pps	25,000-35,000 pps	3,000 pps	
Scan rate	7.5/15 rpm	6/12 rpm	15/30 rpm	16 rpm	33 rpm		60 rpm	

SSDS (AN/SYQ-17 RAIDS) integrated anti-missile system

The initial requirement for a Ship Self-Defense System (SSDS), which led to RAIDS (Rapid Anti-ship missile Integrated Defense System), stemmed from the attack on the frigate USS *Stark*, which was severely damaged by an Exocet anti-ship missile on May 17, 1987. RAIDS is essentially a software-based hard kill/soft kill co-ordinator, which assesses incoming threats in the light of environmental data, 'own ship' performance and characteristics, and tactical doctrine. Having examined the problem, RAIDS provides the Tactical Action Officer (TAO) with clear, concise and timely recommendations on the most effective use of the ship's hard kill assets (Mk 15 Phalanx CIWS and NATO Sea Sparrow missile systems), and its soft kill systems, which include electronic warfare systems, chaff and other decoy systems, as well as ship manoeuvres.

The system uses a distributed architecture, based on Intel 80486 microprocessors linked over an Ethernet-standard local area network (LAN). Three processors provide tactics, track management and environmental interface support, one supports two remote displays and a third is for the TAO. The remainder act as remote interface units (RIU) for the Sea Sparrow, Phalanx and AN/SLQ-32(V)5 EW systems, the last also linking with the combat direction system. System software is written in the 'C' language, with Microsoft DOS and Windows.

The MMI is based upon the Advanced Display System and consists of two 48.26 cm (19 in) raster scan display consoles which are in the CIC (one for the TAO and the other for the Electronic Warfare Supervisor) and a manoeuvring recommendation display near the helm. Data on tracks and missile defence systems are provided from the combat direction system (usually NTDS) while the weapon systems are monitored through the RIUs. Frequency management displays help to reduce interference between jammers and the CIWS.

An infra-red search and track system is currently being defined and the Navy Sea Systems Command was likely to begin an engineering and manufacturing development programme in 1995. A related programme designated Radiant Mist also exists to combine electro-optic sensors in a similar role, which could acquire targets at 5 n miles (10 km).

SONARS

The anti-submarine warfare system comprises the Mk 116 Mod 7 ASW fire-control system, the AN/SQQ-89(V) combat system and a sonar suite consisting of AN/SQS-53 bow-mounted sonar array, the AN/SQR-19 (TACTAS) towed array, and the AN/SQQ-28 SSPS which process data received from the LAMPS I/III helicopter.

Mk 116 Mod 7 anti-submarine fire-control system

The Mk 116 Mod 7 Underwater Fire-Control System is designed to provide tactical data processing, contact management, target engagement processing and weapon fire control and consists of two elements: the Computer Processing Subsystem (CPS) and the Weapon Control and Setting Subsystem (WCSS). Data are also received from external sensors and distributed around the system by an integral switchboard or data converter.

The CPS provides displays of tactical data, computes and stores track data, calculates weapon control firing solutions for selected targets and generates weapon recommendations and launcher orders. Most systems are based upon NTDS hardware with an AN/UYK-7 computer with a memory of 256,000 32-bit words and an optimum processing power of 667,000 operations a second. The newest systems have two AN/UYK-43B computers, each of which has two Central Processing Units (CPU) with a memory of 2,560,000 words and an optimum processing power of 3,002,000 operations a second. Both systems use the US Navy's own CMS-2 language.

The WCSS consists of the Mk 329 weapon control panel which selects the fire-control mode, the sensor-weapon pairing, weapon and launcher, torpedo presetting and then launches the weapon. The external sensors all include an electromagnetic log and the Type F wind indicator. The other sensors and the data distribution unit are tabulated alongside.

The prime sensor is the bow-mounted, low-frequency AN/SQS-53 active/passive sonar which is produced by the General Electric Company's Electronic Systems Division (SQS-53A)

Manufacturer/Contractor
Loral Librascope.

AN/SQQ-89(V)6 or (V)8 anti-submarine combat system
The AN/SQQ-89(V) surface ship anti-submarine warfare combat system detects, locates, tracks and engages submarine targets, and transmits and/or receives acoustic signals using a variety of sensors. Received signals are processed to provide target classification as well as performing Target Motion Analysis and controlling the setting of 'own ship' ASW weapons. In addition it provides multisensor track correlation, track management control and forwards track data to ship's Combat Direction System (CDS) or Command and Decision System (C&DS). The system is an integrated combat system consisting sonar sensors which interface with the Mk 116 fire-control system to provide maximum operational effectiveness combined with minimum manpower requirements.

In the 'Spruance' class, the sensors integrated in AN/SQQ-89(V) are the AN/SQS-53B/C hull-mounted sonar, AN/SQR-19(V) Tactical Towed Array Sonar (TACTAS), and the AN/SQQ-28 LAMPS I/III Sonar Signal Processing System (SSPS). These are supported by the AN/UYQ-25 Data Processing System (DPS) and its associated Sonar In-Situ Mode Assessment System (SIMAS) computer program. The fire-control subsystem is the Mk 116 Mods 5-9.

All SQQ-89(V) fits aboard the Spruances have been upgraded and ships are now fitted as follows:

SQQ-89(V)6: DD 982, 984-989, 963-973, 975-977, 980, 981, 984, 989, 991, 992, 997.

SQQ-89(V)8: DD 969, 972, 974, 976, 977, 979, 983, 990, 997.

AN/SQS-53
The prime sensor is the bow-mounted, low-frequency AN/SQS-53 active/passive sonar, which has a cylindrical array 1.6 m high and 4.8 m in diameter with 576 transducers. The sonar is reported to have an active transmitting frequency of about 3 kHz and a peak frequency of 192 kHz. SQS-53 operates in three active modes; surface duct, bottom bounce and convergence zone, and ranges are reported to be approximately 10 n miles (18.5 km) in surface duct mode and up to 34.5 n miles (64 km) in convergence zone mode. Passive detection range is reportedly greater than the previous SQS-26 with the ship capable of operating at higher speeds, which helps to give the system a multiple target tracking capability.

The SQS-53C is an upgraded version of SQS-53B which can detect, classify and locate both subsurface and surface targets using active and passive means. It consists of four major subsystems, the array, the transmitter, the receiver and the control/display.

AN/SQR-19(V)
The AN/SQR-19(V) is a passive, long-range omnidirectional system for detecting and classifying submarine targets. Its OA-9056/SQR-19 towed array group consists of an 82 mm (3.2 in) diameter array, which is towed on a 1 n mile (1.7 km) cable to depths as low as 365 m (1,200 ft). The other two major subsystems are the Ship-based Electronic Subsystem (SES) and the OK-410/SQR-19 Handling and Stowage Group (H&SG). Early versions of AN/SQR-19 use the AN/UYK-20 Data Processing Set (DPS) but systems produced from FY87 onwards use the AN/UYK-44-based Signal Data Processing Unit (SDPU).

AN/SQQ-28(V)9 Sonar Signalling Processing System
The AN/SQQ-28 SSPS was originally designed as the shipboard processor for the LAMPS III weapon system. It processes raw data from sonobuoys laid by the Sikorsky SH-60B Seahawk ASW helicopter and relayed to the ship via the AN/SQR-4 duplex digital link and received by the AN/ARR-75. LAMPS I acoustic data, from sonobuoys laid by the Kaman SH-2F Seasprite, is received by the AN/SKR-4B(V) receiver. Modifications to the SKR-4 interface allow LAMPS I and LAMPS III interoperability, and shipboard sonobuoy receiver set or training acoustic inputs to the datalink port of the SQQ-28 Input Signal Switching Unit (ISSU). When SQQ-28 is installed in ships with the AN/SQR-19, it shares the DPS or the SDPU.

The AN/UYQ-25 DPS and the associated SIMAS provide a computer-based capability for sonar in-situ performance prediction and mode selection to provide the most effective AN/SQQ-89 system performance in various environmental conditions. With the exception of a few of the early 'Ticonderoga' class cruisers, the version used in SQQ-89 is the AN/UYQ-25A(V)2.

AVIATION

AVIATION FACILITIES

Specification
Flight deck: 22.7 × 11 m (74.5 × 36 ft)
Hangar: 17.6 × 11 m (58 × 36 ft)

HELICOPTERS

Two Sikorsky SH-60B Seahawk (LAMPS III)

Specifications
Dimensions
Main rotor diameter: 16.36 m (53.66 ft)
Tail rotor diameter: 3.35 m (11.00 ft)
Length overall (fuselage): 15.26 m (50.0 ft)
Height (to top of rotor head: 3.79 m (12.43 ft)
Weights:
empty: 6,191 kg (13,648 lb)
mission gross weight: 9,182 kg (20,244 lb)
Performance:
dash speed (typical): 126 kts (234 km/h)
vertical rate of climb at S/L: 213 m (700 ft)/min
Power plant: 2 General Electric T700-GE-401C turboshafts rated at 1,417 kW (1,900 shp)
Accommodation: Pilot and airborne tactical officer/back-up pilot in cockpit, sensor operator in specially equipped station in cabin
Communications: Collins AN/ARC-159(V)2 UHF, Collins AN/ARC-174(V)2 HF, Hazeltine AN/APX-76A(V) and Bendix/King AN/APX-100(V)1 IFF transponders, TSEC/KG-45(E-1) communications security set, TSEC/KY-75 voice security set, Telephonics OK-374/ASC communications system control group
Mission avionics: Sikorsky sonobuoy launcher, Edmac AN/ARR-75 and R-1651/ARA sonobuoy receiving sets (AN/ARR-84 receiver in Block 1 upgrade), Texas Instruments AN/ASQ-81(V)2 towed MAD, Raymond MU-670/ASQ magnetic tape memory unit, Astronautics IO-2177/ASQ altitude indicator, Fairchild AN/ASQ-164 control indicator set, Fairchild AN/ASQ-165 armament control indicator set, IBM AN/UYS-1(V)2 Proteus acoustic processor and CV-3252/A converter display, Control Data AN/AYK-14 (XN-1A) digital computer, Raytheon AN/ALQ-142 ESM, Sierra Research AN/ARQ-44 datalink and telemetry
Armament: 2—46 torpedoes AGM-119B Penguin Mk 2 Mod 7 anti-shipping missiles. Block I upgrade integrated Penguin and Honeywell 50 Advanced Lightweight Torpedo

PROPULSION

Specifications
System: Combined gas-and-gas (COGAG)
Main machinery: 4 General Electric LM-2500 gas turbines; 64.16 MW (86,000 hp) sustained
Shafts: 2
Propellers: cp

FURTHER INFORMATION

PROGRAMME

The 'Spruance' class was built to replace the many 'Gearing' and 'Allen M Sumner' class destroyers, which, by the 1970s had exceeded their useful lives, at least as far as a front-line navy was concerned. It quickly became apparent that the programme would be extremely expensive and one of the methods used to minimise costs was to order the entire class of 31 ships from one shipyard, which provided nine years work for the selected yard, Ingalls at Pascagoula.

The funds were approved between FY70 and FY78, and the hulls were laid down between 1972 and 1980.

The US Congress attempted to have the last ship of the class, *Hayler* (DD 997), completed as an 'air-capable' ship, with a larger hangar capable of accommodating four SH-60B ASW helicopters. This proved to be so expensive that, in the event, the proposal was shelved and the ship was eventually completed to be virtually identical with the others in the class, although it has a wider hangar than the others.

DESIGN

The 'Spruance' class was designed in accordance with the US Navy's late 1960s philosophy, which aimed to minimise platform costs in order to make the maximum funding available for weapons systems. There was also a requirement to create margins of displacement and volume available so that new weapons and sensors could be accommodated during the ships' 25-30 years life span. The limiting displacement is 8,800 t and this is now being approached, full load having risen from the original figure of 7,000 to today's 8,040 t.

Thus, the Spruances were designed with a large hull, which, with a full load displacement of 8,040 t, exceeded that of the 'Gearing' class (3,493 t) and of the 'Allen M Sumner' class (3,210 t) by a factor of 2.5.

Extensive use was made of the modular concept, in order to facilitate construction, maximise internal volume and to facilitate block modernisation. There is a high level of automation, but even so the original crew total of 230 has now climbed to approximately 340. Superstructure is constructed of aluminium alloy.

Hull form is designed to minimise rolling and pitching and there are no fin stabilisers.

These were the first large US warships to employ gas-turbine propulsion, both to provide flexible power and for ease of maintenance and replacement.

The design also incorporated advanced self-noise reduction features such as Prairie/Masker. Kevlar armour was used to protect all vital spaces.

When the ships first entered service there was considerable criticism of the design in the United States, especially from certain sections of the Congress and the Press. The main reason for this was that, at a time when Soviet Navy ships were bristling with weapons and sensors, the Spruance class looked almost naked. The 'Kara' class, for example, had just entered service and seemed to be covered in missile launchers, guns and other weapons, and to have a small forest of radar arrays. The 'Spruance', on the other hand, had a long foredeck upon which the single 127 mm gun and

ASROC launcher appeared almost lost and many items, such as the torpedo tubes, were totally hidden within the superstructure. To make matters worse, there was only a very small number of radar arrays, and the individual arrays appeared much less imposing than those of the Soviet ships.

It has come to be accepted, however, that whatever the superficial deficiencies of the 'Spruance' class may be, it makes up in real capability what it seems to lack in appearance.

The success of the basic design can be gauged by the fact that the hull and propulsion system have been adopted, virtually unchanged for both the 'Ticonderoga' class cruisers for the US Navy and for the 'Kidd' class destroyers originally ordered for the (then) Imperial Iranian Navy.

MODERNISATION

Major overhauls, starting in FY86 have included major improvement programmes. Twenty-four of the class have been converted to VLS 41 and these ships are capable of launching Standard SM-2MR for control by Aegis-fitted vessels. That leaves seven (DDs 974, 976, 979, 983, 984, 989 and 990) with the original type of launchers, but these are all in the process of losing their 116 ASROC launchers. Two of the seven may be upgraded to VLS Mk 41 in FY99.

All have had their EW suite upgraded to AN/SLQ-32V(2) plus Sidekick; two also have AN/WLR-1.

DD 969, 972, 976-78 and 982-990 still operate LAMPS-I with its associated SH-2 helicopter. The remainder have all converted to LAMPS-III/SH-60B, of which DD 974, 978, 980-987 and 989 are now equipped to launch Penguin Mk 2 Mod 7 SSMs. LAMPS-III ships also have had the Indal RAST (recovery, assist, secure and traverse) system fitted.

Trials

It is inevitable that such a numerous class should be used to trial new systems. Such trials have included:

a remote-controlled semi-submersible minehunting device — *John Young* (DD 973)

RAM launcher, including trial firings, of which 11 out of 13 were successful — *David R Ray* (DD 971) (December 1986)

SALGP (Semi-Active Laser-Guided Projectile) Prototype Mod 3, a new 127 mm round, will start trials in 1998

AN/SQQ-89 initial trials were conducted in FY84 aboard the *Moosbrugger* (DD 980) with the prototype system beginning trials in January 1986

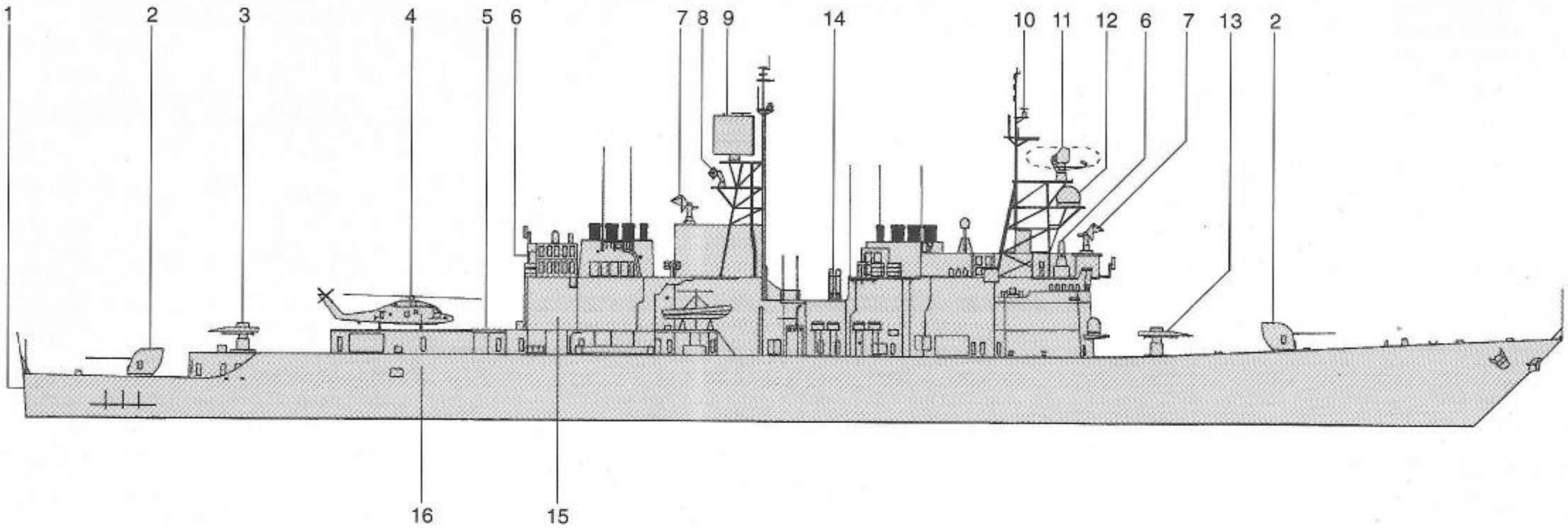
Spruance (DD 963) was used to evaluate RAIDS (rapid anti-ship missile integrated defence system) which is now being installed in all of class during 1996/97.

Arthur W Radford (DD 968) is earmarked for an Advanced Closed Mast Sensor System in 1997.

DEPLOYMENT

Fifteen are with the Atlantic Fleet and 16 with the Pacific Fleet, of which three are home-ported at Yokosuka, Japan. Eleven of the class took part in the 1991 Gulf War and *Fife* (DD 991) launched 60 Tomahawk missiles against Iraq, the highest number from any one platform. Three of the class again fired missiles into Iraq in January and June 1993.

KIDD



Callaghan (Ian Sturton)
1 *SLQ-25 Nixie torpedo decoy* **2** *127 mm (5 in)/54 Mk 45 gun* **3** *Mk 26 Mod 4 launcher (44 SM-2MR missiles)* **4** *SH-60B LAMPS-III helicopter* **5** *Flight deck* **6** *Mk 15 Vulcan Phalanx CIWS (opposite corner of hangar roof)* **7** *SPG-510 radar (fire control)* **8** *SPG-60 radar (fire control)* **9** *SPS-48E radar (air search)* **10** *SPS-55 radar (surface search)* **11** *SPS-49(V)5 radar (air search)* **12** *SPQ-9A radar (fire control)* **13** *Mk 26 Mod 3 launcher (24 SM-2MR missiles)* **14** *Harpoon (eight launchers)* **15** *Hangar* **16** *Three 324 mm Mk 32 torpedo tubes*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: USA

Class: KIDD

Built: 4
Active: 4

Displacement:
standard: 6,950 t
full load: 9,574 t

Dimensions:
Length: 171.7 m (563.3 ft)
Beam: 16.8 m (55 ft)
Draught: 6.2 m (20 ft); 10 m (33 ft) sonar

Speed: 33 kts
Range: 3,300 n miles at 30 kts; 6,000 n miles at 20 kts; 8,000 n miles at 17 kts

Complement: 339 (20 officers)

SHIPS

KIDD (DDG 993) (ex-Kouroosh)

Builder	Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down	26 Jun 1978
Order cancelled by Iran	3 Feb 1979
Acquired by USA	25 Jul 1979
Launched	11 Aug 1979
Commissioned	27 Jun 1981
New threat upgrade (NTU) completed	Sep 1989

CALLAGHAN (DDG 994) (ex-Daryush)

Builder	Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down	23 Oct 1978
Order cancelled by Iran	3 Feb 1979
Acquired by USA	25 Jul 1979
Launched	1 Dec 1979
Commissioned	29 Aug 1981
New threat upgrade (NTU) completed	Jul 1990

SCOTT (DDG 995) (ex-Nader)

Builder	Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down	12 Feb 1979
Order cancelled by Iran	31 Mar 1979
Acquired by USA	25 Jul 1979
Launched	1 Mar 1980
Commissioned	24 Oct 1981
New threat upgrade (NTU) completed	Mar 1988

CHANDLER (DDG 996) (ex-Anoushirvan)

Builder	Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down	7 May 1979
Order cancelled by Iran	31 Mar 1979
Acquired by USA	25 Jul 1979
Launched	24 May 1980
Commissioned	13 Mar 1982
New threat upgrade (NTU) completed	Aug 1990

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas UGM-84B Harpoon

Eight Harpoon anti-ship missile canisters are mounted immediately aft the forward stack. The missiles are Block 1C versions, with certain additional options compared to earlier versions, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. Block 1C missiles can also use selectable seeker search expansion patterns, and for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 lb)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n miles (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

SURFACE-TO-AIR MISSILES (SAM)

Standard Missile-2 Medium Range (SM-2MR)

These four ships were originally armed with Standard SM-1MR missiles, but now carry Standard SM-2MR Block III, which can be used for surface-to-air (including passive home-on-jam) and surface-to-surface engagements. The propulsion section uses the Thiokol Mk 104 dual-thrust rocket motor with ARC acting as second source. The SM-2 missile's course is controlled from the ship by means of an RF link until the target comes within the missile seeker's field-of-view. This system allows the use of the ship's search radar to provide missile launch data and by shaping the missile flight path into an energy-efficient trajectory the effective range of the system is doubled.

There is a Launcher Mk 26 Mod 3 with a 24 missile magazine forward, with a Mk 26 Mod 4 launcher and 44 missile magazine aft. ASROC missiles used to be carried in the after magazine as well, but have been withdrawn, enabling the ships to carry 68 Standard SM-2MR missiles.

Specifications

(SM-2MR)
Length: 4.72 m (15.49 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.06 m (3.47 ft)
Weight: 706.7 kg (1,558 lb)
Speed: Mach 2.5
Range: 37.75 n miles (70 km)
Altitude: 19,800 m (65,000 ft)
Guidance: Semi-active radar homing

Manufacturers/Contractors

Hughes Missile Systems, Tucson, Arizona, USA.
Raytheon Missile Systems Division, Bedford, Massachussetts, USA.

TORPEDOES

324 mm Mk 32 triple torpedo launchers

Two triple Mk 32 torpedo launchers are mounted, one on either beam, inside the superstructure below the flight deck. This protects them from the elements, enables them to use a central magazine and also facilitates maintenance. A shutter is raised to enable the tubes to fire.

Honeywell Mk 46 or Alliant/Westinghouse Mk 50 torpedoes

The ship carries 14 Honeywell Mk 46 Mod 5 torpedoes.

GUNS

Mk 45 Mod 0 single 127 mm (5 in) L/54 gun mounting

Two single 127 mm Mk 45 Mod 0 guns are mounted, one forward, the second aft. The weapon fires semi-fixed ammunition with point detonating, proximity (variable time or infra-red), mechanical time and electronically set fuzes. The theoretical rate of fire is 20 rds/min and a gun crew of six is required, all below decks, of which four are ammunition handlers.

Specifications

Calibre: 127 mm (5 in)
Length of barrel: 54 calibres
Muzzle velocity: 807.72 m/s (new barrel), 762 m/s (mid-life)
Crew: 6 (1 mount captain, 1 panel operator, 4 ammunition handlers)
Traverse: 340° at 30°/s
Elevation: −15 to +65° at 20°/s
Range:
anti-ship: 12.39 n miles (23 km)
anti-air: 15,000 m (49,000 ft)
Rate of fire: 16-20 rds/min
Ammunition weight: 31.75 kg (projectile)

Manufacturer/Contractor

United Defense, Armament Systems Division, Minneapolis, Minnesota, USA.

Hughes Mk 15 CIWS Phalanx

Two Hughes Mk 15 Phalanx close in weapons systems (CIWS) provide the innermost layer of defence against anti-ship missiles. One mount is located on the starboard side of the bridge roof, the other on the port side of the hangar roof. Each mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n miles (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds.

Specifications

Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturers/Contractors

Hughes Missile Systems, Tucson, Arizona, USA (system).

Machine guns

Four 12.7 mm (0.50 in) M2 machine guns.

Specifications

Calibre: 12.7 mm (0.50 in)
Rate of fire: 450-550 rds/min
Muzzle velocity: 883 m/s (2,900 ft/s)
Max effective range:
anti-surface: 6,700 m (7,400 yd)
anti-air: 1,380 m (4,500 ft)

Callaghan *(DDG 994) is one of four 'Kidd' class destoyers which were ordered by the (then) Shah of Iran in 1978 but the order was cancelled following his downfall and the ships were acquired by the US Navy for $510 million each* (H & L van Ginderen Collection)

ELECTRONIC WARFARE SYSTEMS

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher

There are four Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units, with two pairs mounted on small platforms either side of the forward stack.

Specifications

Launcher

Dimensions: 160 × 43 × 86 cm (63 × 17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 2.2 n miles (4 km)

Rounds

Mk 182: 1,209 × 130 mm; 22.7 kg
Super Chaffstar: 1,209 × 130 mm; 20.9 kg
Super Gemini: 451 × 130 mm; 5.5 kg
Super Hiram III: 1,220 × 130 mm; 13.6 kg
Super Hiram IV: 467 × 130 mm; 3.8 kg
Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturers/Contractors

Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

AN/SLQ-25 Nixie noisemaker

The AN/SLQ-25 Nixie is a solid-state, electro-acoustic countermeasures decoy system used to protect the ship from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals into acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 487.5 m (1,600 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408.24 kg (900 lb). The towed bodies, which are streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 94.6 cm (37 in) long, 15.24 cm (6 in) in diameter and weigh 18.14 kg (40 lb). Usually one towed body at a time is deployed.

Manufacturer/Contractor

Aerojet ElectroSystems, Sacramento, USA.

AN/SLQ-32(V)5 Sidekick ESM Suite

The AN/SLQ-32(V)5 suite has been added since the ships were completed. This is designed to give radar warning and jamming/deception and is essentially the same as AN/SLQ-32(V)2 but with the addition of the Raytheon Sidekick active jammer.

Manufacturer/Contractor

Raytheon Company, Electromagnetic Systems Division, Goleta, California.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

ACDS Block 1 Level 1

ACDS (Advanced Combat Direction System) was installed in the 'Kidd' class destroyers during their NTU refits. ACDS Block 1, introduces Link 16, increases track capacity significantly, has automatic identification and decision aids, and also features new command, communications, control and information interfaces.

ACDS with the Mk 14 Weapon Direction System, the Mk 86 gun fire-control system and SWG-1A (Harpoon control system) as well with the Mk 116 underwater fire-control system. The Block 1 system has three AN/UYK-43B processors: one each for track management and decision support, as well as a Command and Control Processor (C^2P) based upon an AN/UYK-43B rehosted in commercial off-the-shelf hardware. The C^2P controls the datalink systems and data provided through satellite links and displays it on an AN/USQ-69 console. The software package features a database of approximately 1 million lines of code and additional dedicated ship-fits of code each of which can be up to 1 million lines. Block 1 includes a Link 16 interface to help identify not only ship classes but also individual ships by collating historical tracking data. The Block 1 systems are also able to interface with the Naval Tactical Command System-Afloat (NTCS-A). The ACDS uses the UYQ-21 display family including PT-525 large screen displays.

Manufacturers/Contractors

Unisys (computer).
Hughes Aircraft Company (displays).
Collins (communications).

COMMUNICATIONS AND DATALINKS

Link 4A
Link 11
Link 14
Link 16 (being fitted)
JMCIS (being fitted)
Satcom SRR-1
Satcom WSC-3 (UHF)
Satcom USC-38 (EHF)
Tacan: URN 25
IFF XII
AIMS UPX-29.

WEAPONS CONTROL

AN/SWG-1A Harpoon Launch Control System (LCS)

SWG-1A is the Harpoon weapons control system, which activates the missile, selects the flight pattern and sets seeker search modes (with small, medium or large acquisition windows), as well as providing target range and bearing data. Alternatively, the missile can simply be launched along the bearing of the target, with the seeker activated early to scan a 90° sector; if, after a set time, no target has been acquired the missile commences a preset search pattern. SWG-1A takes account of other ships in the general target area and generates indirect flight plans for the missile, including waypoints to optimise angles of approach which will achieve the highest possibility of success while minimising the chances of the missile being destroyed by hostile fire. It can also be used to compute flight plans in a multiple attack so that several missiles, from either the same or different ships, arrive on target simultaneously, thus swamping the defences.

Mk 74 Mod 5 fire-control system

There are two Mk 74 Mod 5 missile fire-control systems, which acquire, track and illuminate targets assigned to them by the Weapon Direction System (WDS) Mk 15 Mod 5. They operate with a missile handling/launching system but are not involved in the launch sequence, which is controlled by the WDS. The Mk 74 also carries out a post-engagement evaluation.

The system consists of the UniSys AN/UYK-7 computer system, supported by Mk 72 Mod 13 signal data converter, an AN/SPG-51 G/H-I/J-band radar, a Mk 73 Mod 2 director and associated consoles. The SPG-51C radar has two independent channels each with a G/H-band tracking radar and an I/J-band illumination transmitter. This radar has longer detection and acquisition ranges than its predecessor, and automatic target scheduling, which require fewer operator decisions. The console with this system was the dedicated OJ-101. The Mod 14 radar incorporates a universal CW injection modulator in the CW injection transmitter to provide an uplink for the SM-2 missile and a monopulse receiver for more accurate angle tracking.

The Mk 73 director is a rotating electronic structure which includes the transmitter group, the control power supply for CW injection, the power supply for the pulse Doppler system, and a radar data converter. It can traverse up to 360° while elevation limits are −30 to +83°.

Manufacturer/Contractor

Raytheon Company, Equipment Division, Marlborough, Massachusetts, USA.

Gun Fire Control System (GFCS) Mk 86 Mod 5

GFCS Mk 86 controls direct and indirect naval gunfire support and also assists in the engagement of both surface and air targets. It has a mainframe architecture using CMS-2 software language and consists of a computer system, a display system and three sensors, and accepts data from ACDS, the Mk 74 fire-control system and optical Target Designation Transmitters. The Mk 86 Mod 5 system installed in the 'Kidd' class is configured to control two 5 in guns for defence against surface and air targets, and for shore bombardment and uses two AN/UYK-7 32-bit computers, each with a memory of 256,000 words and an operating speed of 667,000 operations per second. The system can track 120 targets simultaneously.

The primary sensors are the AN/SPQ-9A and AN/SPG-60 fire-control radars for surface and air engagements respectively, as well as a remotely operated electro-optic tracker known as the Remote Optical Sight (ROS) of which there are usually two. Another electro-optical tracker (also designated an ROS) is attached to the AN/SPG-60 antenna mounting. Both radars are subject to improvement.

The AN/SPQ-9 is a high-resolution, track-while-scan, pulse compression I-band radar with a peak power of 1.2 kW and a PRF of 3,000 pps which has a basic capacity of four targets which may be expanded to more than 100. It provides detection and tracking facilities of surface targets at ranges between 135 m and 20 n miles (37 km) and limited air cover at altitudes up to 610 m. The radar operates in one of five selectable frequency ranges with pulse-to-pulse frequency agility. The system features a high scanning rate to provide a one second data rate, real-time signal and data processing, while an MTI facility has been developed to enhance sub-clutter visibility. The AN/SPG-60 is a four-horn amplitude-comparison monopulse I/J-band pulse Doppler radar which can acquire and track targets at ranges up to 100 n miles (185 km). The search-to-acquire capability is computer directed and the radar can accept 2D and 3D target designation co-ordinates in digital or synchro format. Tracking may be conducted automatically or manually. The radar can operate on a large number of different pulse repetition frequencies with up to six scanning patterns. The antenna includes an electro-optic sight (designated an ROS).

Targets acquired by the ship's search radars, missile fire-control radars and EW system are evaluated by the Combat Information Center (CIC) which designates them to the Mk 86 Combat Operations Center (COC). They are then assigned to a Weapon Control Center (WCC) together with a gun or guns for acquisition and tracking which are monitored by the COC operator. The Gunfire Control Centre (GCC)/WCC operator checks the ballistic solution and commands the loading and firing of the gun or guns.

Several operational modes are available:

Radar Surface Fire. Upon target acquisition, a track-while-scan routine is used to track simultaneously multiple designated targets. Smoothed radar data with appropriate ballistics data, are used to compute weapon orders.

Air Action. The computer automatically and adaptively controls search patterns to acquire and track air targets. Target data, plus a TV view along the SPG-60 boresight axis, are displayed on a weapon control console. The engagement with SM-2 missiles is facilitated by virtue of continuous wave illumination injection to

the SPG-60 tracking radar. A pre-action calibration of gun weapons can be initiated from the weapon control consoles.

Anti-Ship Missile Defense (ASMD). The track-while-scan acquisition gate is expanded to a range sufficient for threat detection. (Full 360° coverage, or coverage over a number of segments to provide surveillance of selected areas, can be chosen.) All targets passing through the acquisition gate are then automatically detected by the system. After target detection, the following functions are performed automatically: (a) threat evaluation (b) weapon assignment (c) assignment of targets to tracking channels (d) slewing of AA director and a weapon to the target (e) scan of AA director and 3D track of targets (f) initiation of firing; transfer of fire to second target.

Visual Surface Fire. A future facility will allow the weapon controller to track the target visually with the TV system and fire the laser to obtain range data. Target range and angle data are entered into the system automatically, and ballistics are computed. Indirect shore bombardment for shore fire support missions or engagement of targets that are not within view of either radar or optical sensors, target and 'own ship' co-ordinates are entered at a weapon control console. The system automatically updates these with inputs from the ship's compass and log, or by means of a beacon or other navigational aids. Spotting data is entered at the keyboard. Automatic compensation for orientation of the target line by an on-shore observer is provided.

Manufacturer/Contractor

Lockheed Electronics Company Inc, Nashua, New Hampshire, USA.

WDS Mk 14 target designation system

The WDS Mk 14 is a digital target designation system which receives hostile target indications and assignations from the ACDS. The Weapon Direction System (WDS) then evaluates target engageability, assigns priorities and transmits these data to the missile fire-control system, while retaining responsibility for weapon assignment, loading orders and launching. In the post-launch period the WDS conducts in-flight missile monitoring and control, then conducts a post-engagement evaluation.

The WDS also monitors data flow between the NTDS computer, the fire control and the launching systems, and, depending upon the tactical situation and computer recommendations, operators can also control both the fire control and the launching systems and then fire missiles.

The Mk 14 not only assigns targets for missile engagement (it is capable of engaging multiple targets) but also for gun engagements. All launcher and radar commands are automatically generated and displayed together with recommendations on priorities and the time to start the engagement. The system is capable of controlling several channels of fire simultaneously. To assist this process it has its own processors, two AN/UYK-20A computers (AN/UYK-44 in later systems), and two or three OJ-194(V)4 consoles (AN/UYA-4 display family); one for the weapon engagement co-ordinator and the other for missile engagement controllers (one per missile launcher). There is an AN/SYR-1 communications tracking set to provide missile track data from the missile downlink. Mk 14 systems have also been modified to operate in a more severe ECM environment and can control the missile while it performs what are officially described as 'radical terminal phase manoeuvres'.

Manufacturer/Contractor

Vitro Corporation, Rockville, Maryland, USA.

AN/SYS-2(V)2 data fusion system

The role of the SYS-2(V)2 IADT (Integrated Automatic Detection and Tracking system) is to increase the number of air and surface targets which may be detected and tracked in all types of electronic environments. The system accepts contacts from each radar, seeks potential targets, correlates the data by comparing all the sensors' returns and then produces a single file of valid tracks, while avoiding duplication. The different radar characteristics provide an overlapping volume of coverage in a variety of clutter and ECM environments which may be monitored to obtain the best possible search coverage. The data is then fed to the ship's command and weapon control systems, and accepts inputs from fire-control radars.

Each system consists of two 16-bit Paramax AN/UYK-44 computers and two display consoles. In later systems 32-bit digital microprocessors are added to improve sensor data fusion. The AN/UYK-44 is capable of 900 Kops. Supplementary processors are the Motorola 68020, the INMOS Transputer (801/5) and the Intel i860 RISC. The UYK-44 uses Ultra-16 Assembly language and Ada is planned for SYS-2. The transputer uses OCCAM software language. In most systems one computer is used to interface with the sensors and the inertial navigation system while the other supports the display consoles and interfaces with the combat direction system, and fire/weapon control systems.

In SYS-2 (V)2 one computer supports the AN/SPS-49 radar which acts as the long-range tracker while the second interfaces with the Mk 92 fire-control system and, through the preprocessor, with the AN/SPS-55 radar which acts as the medium-range tracker.

Manufacturer/Contractor

Norden Systems, Melville, New York, USA.

SONARS

Mk 116 Mod 7 anti-submarine fire control system

The Mk 116 Underwater Fire Control System is designed to provide tactical data processing, contact management, target engagement processing and weapon fire control and consists of two elements: the Computer Processing Subsystem (CPS) and the Weapon Control and Setting Subsystem (WCSS). Data are also received from external sensors and distributed around the system by an integral switchboard or data converter.

The CPS provides displays of tactical data, computes and stores track data, calculates weapon control firing solutions for selected targets and generates weapon recommendations and launcher orders. Most systems are based upon NTDS hardware with an AN/UYK-7 computer with a memory of 256,000 32-bit words and an optimum processing power of 667,000 operations per second. The newest systems have two AN/UYK-43B computers, each of which has two Central Processing Units (CPU) with a memory of 2,560,000 words and an optimum processing power of 3,002,000 operations per second. Both systems use the US Navy's own CMS-2 language.

In Mk 116 Mod 7 the WCSS consists of the Mk 329 weapon control panel which selects the fire-control mode, the sensor-weapon pairing, weapon and launcher, torpedo presetting and then launches the weapon. The external sensors include an electromagnetic log and the Type F wind indicator. The other sensors and the data distribution unit are tabulated alongside.

The prime sensor is the bow-mounted, low-frequency AN/SQS-53 active/passive sonar.

Manufacturer/Contractor

Loral Librascope.

AN/SQS-53

The prime sensor is the bow-mounted, low-frequency AN/SQS-53 active/passive sonar, which has a cylindrical array 1.6 m (5.2 ft) high and 4.8 m (15.7 ft) in diameter with 576 transducers. The sonar is reported to have an active transmitting frequency of about 3 kHz and a peak frequency of 192 kHz. The SQS-53 operates in three active modes; surface duct, bottom bounce and convergence zone, and ranges are reported to be approximately 10 n miles (18.5 km) in surface duct mode and up to 34.5 n miles (64 km) in convergence

RADARS

	SPS-48E	SPS-49(V)5	SPS-55	SPS-64(V)9
Manufacturer	ITT	Raytheon	Cardion	Raytheon
Role	3D air search	Air search	Surface search	Navigation
Band	E/F	C/D (0.5-2 GHz)	I/J (8-20 GHz)	I
Beam	1.5 × 1.6°	3.4 × 30° csc²	1.5 × 20°	1.9 × 22°
Peak power	2,200 kW	360 kW	130 kW	20 kW
Gain	38.5 dB	28.5 dB	31 dB	28 dB
Pulsewidth	3 µs	125 µs/2 µs	1/12 µs	0.06/0.5/1.0 µs
PRF	1,250-2,000 pps	280/800/1,000 pps	750/2,250 pps	3,600/1,800/900 pps
Scan rate	7.5/15 rpm	6/12 rpm	16 rpm	33 rpm

FIRE CONTROL RADARS

	SPG-51D (two)	SPG-60	SPQ-9A
Manufacturer	Raytheon	Lockheed	Lockheed
Role	Fire control (SAM)	Fire control	Fire control
Fire-control system		Mk 86	Mk 86
Band	G/I	I/J	I/J
Beam	1.6°	12 × 1.2°	1.35 × 3°
Peak power	81 kW	5.5 kW	1.2 kW
Gain	39.5 dB	41.5 dB	37 dB
Pulsewidth	2.1-3.2 µs	0.27/1/6 µs	0.3-16 µs
PRF	4,100 pps	25,000-35,000 pps	3,000 pps
Scan rate	—	—	60 rpm

This stern view of Kidd *(DDG 993) shows the after 127 mm (5 in) gun and the Mk 26 Mod 4 twin-arm launcher; there is a magazine holding 44 Standard SM-2MR missiles below the launcher. In many other navies the current practice is to put the helicopter flight deck right aft but in the 'Kidd' and 'Spruance' class the US Navy has placed the flight deck well forward, thus minimising the effect of pitch on flying operations* (H & L van Ginderen Collection)

zone mode. Passive detection range is reportedly greater than the previous SQS-26 with the ship capable of operating at higher speeds, which helps to give the system a multiple target tracking capability.

The improved SQS-53C is currently being evaluated aboard one of the four 'Kidd' class destroyers and may be fitted to all four later.

AN/SQR-19

The ships were not designed to have AN/SQR-19 towed arrays, but this equipment may be installed later.

AN/SQQ-28(V)9 Sonar Signalling Processing Systems (SSPS)

The AN/SQQ-28(V)9 SSPS was originally designed as the shipboard processor for the LAMPS III weapon system. It processes raw data from sonobuoys laid by the Sikorsky SH-60B Seahawk ASW helicopter. It is relayed to the ship via the AN/SQR-4 duplex digital link and received by the AN/ARR-75. LAMPS I acoustic data from sonobuoys laid by the Kaman SH-2F Seasprite, is received by the AN/SKR-4B(V) receiver. Modifications to the SKR-4 interface allow LAMPS I and LAMPS III interoperability and shipboard sonobuoy receiver set or training acoustic inputs to the datalink port of the SQQ-28 Input Signal Switching Unit (ISSU). When SQQ-28 is installed in ships with the AN/SQR-19, it shares the DPS or the SDPU.

The AN/UYQ-25 DPS and the associated SIMAS provide a computer-based capability for sonar in-situ performance prediction and mode selection to provide the most effective AN/SQQ-89 system performance in various environmental conditions. With the exception of a few of the early 'Ticonderoga' class cruisers the version used in SQQ-89 is the AN/UYQ-25A(V)2.

AVIATION

AVIATION FACILITIES

Specifications

Flight deck: 21.0 × 16.8 m (70 ft × 55 ft)
Hangar: As built, the 'Kidd' class had a double hangar for two Kaman SH-2 LAMPS I helicopters, but only one SH-60B is now operated
Landing aid: Indal RAST is being fitted

HELICOPTERS

One Sikorsky SH-60B Seahawk (LAMPS III)

Specifications

Dimensions
Main rotor diameter: 16.36 m (53.66 ft)
Tail rotor diameter: 3.35 m (11.00 ft)
Length overall (fuselage): 15.26 m (50.0 ft)
Height (to top of rotor head: 3.79 m (12.43 ft)
Weights:
empty: 6,191 kg (13,648 lb)
mission gross weight: 9,182 kg (20,244 lb)
Performance:
dash speed (typical): 126 kts (234 km/h)
vertical rate of climb at S/L: 213 m (700 ft)/min
Power plant: 2 General Electric T700-GE-401C turboshafts rated at 1,417 kW (1,900 shp)
Accommodation: 3 (pilot and airborne tactical officer/back-up pilot in cockpit, sensor operator in specially equipped station in cabin)
Communications: Collins AN/ARC-159(V)2 UHF, Collins AN/ARC-174(V)2 HF, Hazeltine AN/APX-76A(V) and Bendix/King AN/APX-100(V)1 IFF transponders, TSEC/KG-45(E-1) communications security set, TSEC/KY-75 voice security set, Telephonics OK-374/ASC communications system control group
Mission avionics: Sikorsky sonobuoy launcher, Edmac AN/ARR-75 and R-1651/ARA sonobuoy receiving sets (AN/ARR-84 receiver in Block 1 upgrade), Texas Instruments AN/ASQ-81(V)2 towed MAD, Raymond MU-670/ASQ magnetic tape memory unit, Astronautics IO-2177/ASQ altitude indicator, Fairchild AN/ASQ-164 control indicator set, Fairchild AN/ASQ-165 armament control indicator set, IBM AN/UYS-1(V)2 Proteus acoustic processor and CV-3252/A converter display, Control Data AN/AYK-14 (XN-1A) digital computer, Raytheon AN/ALQ-142 ESM, Sierra Research AN/ARQ-44 datalink and telemetry
Armament: Two Mk 46 torpedoes; AGM-119B Penguin 2 Mod 7 anti-shipping missiles

PROPULSION

Specifications

System: Combined gas and gas (COGAG)
Main machinery: 4 General Electric LM-2500 gas turbines; 64.16 MW (86,000 hp) sustained
Shafts: 2

FURTHER INFORMATION

PROGRAMME

In 1974 the then Shah of Iran ordered six Anti-Air Warfare (AAW) ships for his rapidly expanding navy. The order was reduced to four before the contract was signed in March 1978. The first two were laid down in 1978 and the second pair was about to be laid down when the Iranian revolution and the takeover of power by Ayatollah Khomeini resulted in the cancellation of the orders for two ships in February 1979 followed by the other two in March 1979. After some discussion, Congress authorised a supplementary appropriation, as a result of which the US Navy acquired the four ships at a cost of $510 million each.

The Imperial Iranian Navy planned to classify these ships as cruisers, but the US Navy decided to classify them as guided missile destroyers (DDG), even though they are, in fact, the largest ships ever to be described as such, being marginally larger than the Japanese 'Kongo' class. Despite being DDGs, their hull numbers actually fit in with the DD series.

DESIGN

The Imperial Iranian Navy required these four ships for AAW missions and the design was based on that of the 'Spruance' class. The hull dimensions, propulsion system and general layout are the same as those of the 'Spruance' class, but there are numerous differences. The main weapons system was the Standard SM-1MR SAM, for which there were two Mk 26 launchers, in place of the ASROC and Sea Sparrow launchers in the 'Spruance' class. The forward magazine held 24 Standard missiles, while the after magazine held a total of 44 rounds, a mix of SM-1MR and ASROC.

The Iranian requirements also included specific measures for protracted operations in the Gulf area, including additional air conditioning and dust filters on the air intakes. The sensor fit was also different from that required by the US Navy, with the AN/SPS-48 being used for both detection of aircraft targets and their designation to the AN/SPG-51 tracker/illuminators, of which there was only one per launcher, instead of two. The sonar suite was also confined to the AN/SQS-53A bow sonar.

These discrepancies with US practice must, however, be seen in context, as these ships were intended for operations in and around the Gulf in the 1980s and would have been then — and, indeed, still would have been today — the largest and most sophisticated warships operated by any Gulf Navy.

MODERNISATION

The ships received a certain amount of modification during their final construction, in order to bring them closer to US requirements and have been regularly upgraded since.

Among the equipment added has been:
eight Harpoon launchers
two 20 mm Phalanx CIWS
AN/SLQ-32(V) countermeasures suite
Mk 36 Super RBOC chaff launchers
URN-25 TACAN

All received the New Threat Upgrade (NTU) modernisation between 1988 and 1990 which involved the installation of updated Mk 74 MFCS for SM-2MR, two new radars — AN/SPG-51D and AN/SPS-49(V)5 — and the Mk 14 weapon direction system. This work also involved the rearrangement of the mainmast and repositioning the AN/SPS-48 and AN/SPG-60 antennas, to make room for the AN/SPS-49, the addition of which markedly improved air picture compilation capability. Kevlar armour was also fitted to protect the most vulnerable parts of the ship.

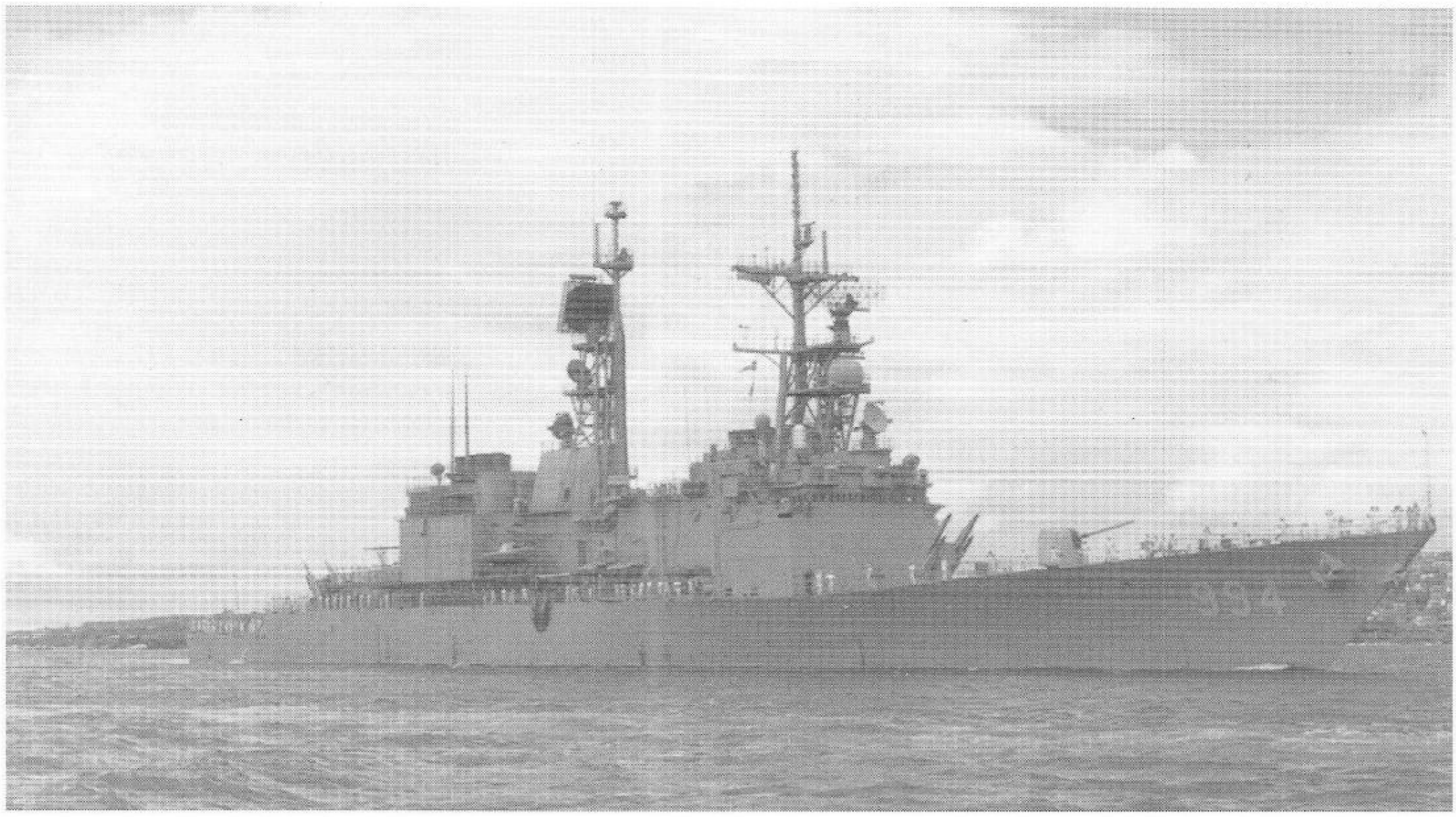
Currently, AN/SQQ-28 sonar signal processors are being fitted to bring the ships up to LAMPS III standard. JMCIS and Link 16 are also to be fitted.

OPERATIONAL

These ships are optimised for general warfare instead of anti-submarine warfare as are the 'Spruance' class. The ability to launch SM-2MR Block 2 enables them to support Aegis cruisers, including, if necessary, allowing Aegis to control the missiles.

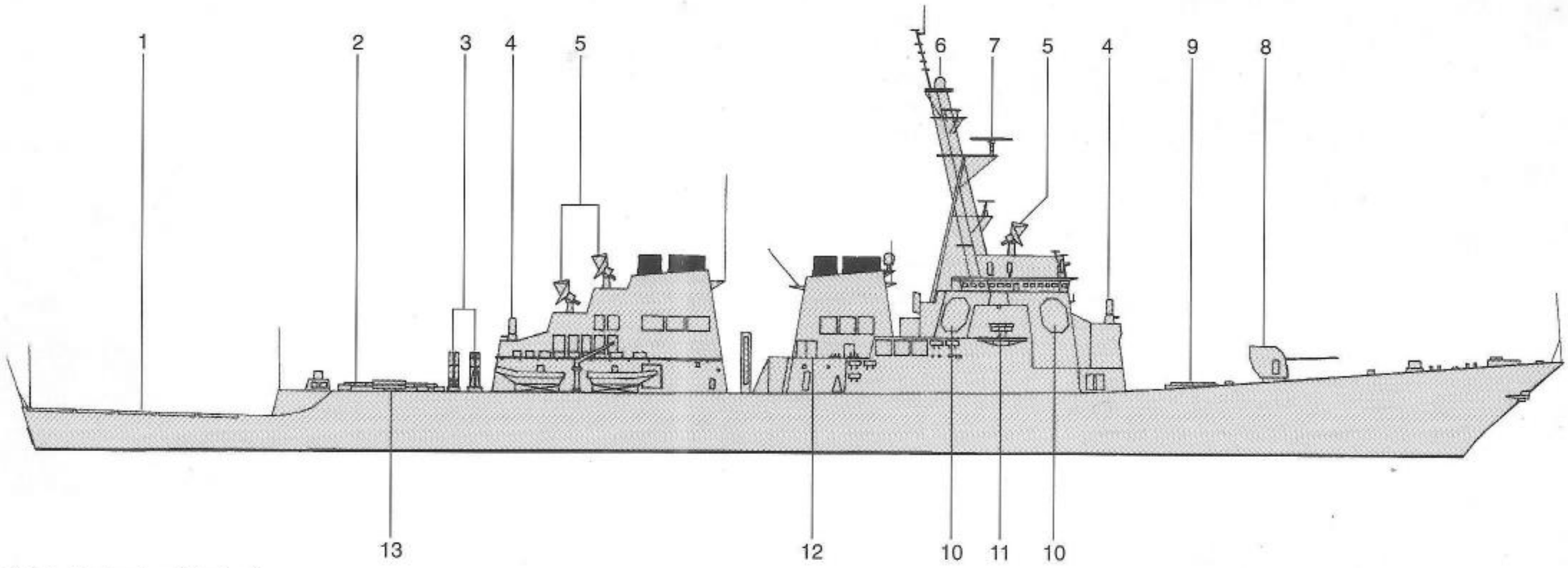
DEPLOYMENT

Two ships serve with the Atlantic Fleet and two with the Pacific Fleet.



Callaghan *(DDG 994). These ships are similar to but by no means identical with the 'Spruance' class. Note that the SPQ-9A is above the SPG-60, the reverse of the 'Spruance' class, while the main mast supports the large square antenna of the SPS-48E, a set not fitted in the 'Spruance' class*

ARLEIGH BURKE (Flights I and II)



Arleigh Burke (Ian Sturton)

1 *Flight deck and facilities to refuel and rearm LAMPS-III helicopters* **2** *Mk 41 Mod 1 vertical launcher (61 missiles)* **3** *Harpoon (eight launchers)* **4** *Mk 15 Vulcan Phalanx CIWS* **5** *SPG-62 radar (fire control)* **6** *URN-25 (Jacan)* **7** *SPS-67(V)3 radar (surface search)* **8** *127 mm (5 in)/54 Mk 45 Mod 1 gun* **9** *Mk 41 Mod 0 vertical launcher (29 missiles)* **10** *SPY-1D phased arrays* **11** *SLQ-32(V)2 (with Sidekick)* **12** *SRBOC Mk 36 Mod 12 chaff launcher* **13** *Triple Mk 32 Mod 14 324 mm torpedo tubes*

GENERAL SPECIFICATIONS

Country of origin: USA
Operator: USA

Class: ARLEIGH BURKE (Flights I and II)

Building: 9
Active: 19

Displacement:
full load: DDG 51 to DDG 71 — 8,422 t; DDG 72 to DDG 78 — 9,217 t

Dimensions
Length:
overall: 153.8 m (504.5 ft)
waterline: 142 m (466 ft)
Beam: 20.4 m (66.9 ft)

Draught:
hull: 6.3 m (20.7 ft)
sonar: 9.9 m (32.4 ft)

Speed: 32 kts
Range: 4,400 n miles at 20 kts

Complement: 303 (23 officers) plus 38 spare

SHIPS

FLIGHT I

ARLEIGH BURKE (DDG 51)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 6 Dec 1988
Launched 16 Sep 1989
Commissioned 4 Jul 1991

BARRY (DDG 52)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 26 Feb 1990
Launched 10 May 1991
Commissioned 12 Dec 1992

JOHN PAUL JONES (DDG 53)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 8 Aug 1990
Launched 26 Oct 1991
Commissioned 18 Dec 1993

CURTIS WILBUR (DDG 54)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 12 Mar 1992
Launched 16 May 1992
Commissioned 19 Mar 1994

STOUT (DDG 55)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 13 Sep 1991
Launched 16 Oct 1992
Commissioned 13 Aug 1994

JOHN S McCAIN (DDG 56)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 3 Sep 1991
Launched 26 Sep 1992
Commissioned 2 Jul 1994

MITSCHER (DDG 57)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 12 Feb 1992
Launched 7 May 1993
Commissioned 10 Dec 1994

LABOON (DDG 58)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 23 Mar 1992
Launched 2 Feb 1993
Commissioned 18 Mar 1995

RUSSELL (DDG 59)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 27 Jul 1992
Launched 20 Oct 1993
Commissioned 20 May 1995

PAUL HAMILTON (DDG 60)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 24 Aug 1992
Launched 24 Jul 1993
Commissioned 27 May 1995

RAMAGE (DDG 61)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 4 Jan 1993
Launched 11 Feb 1994
Commissioned 22 Jul 1995

FITZGERALD (DDG 62)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 9 Feb 1993
Launched 29 Jan 1994
Commissioned 14 Oct 1995

STETHEM (DDG 63)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 11 May 1993
Launched 24 Jun 1994
Commissioned 21 Oct 1995

CARNEY (DDG 64)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 3 Aug 1993
Launched 23 Jul 1994
Commissioned 13 Apr 1996

BENFOLD (DDG 65)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 27 Sep 1993
Launched 9 Nov 1994
Commissioned 30 Mar 1996

GONZALEZ (DDG 66)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 2 Feb 1994
Launched 18 Feb 1995
Commissioned Jun 1996

COLE (DDG 67)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 28 Feb 1994
Launched 10 Feb 1995
Commissioned Jun 1996

THE SULLIVANS (DDG 68)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 27 Jul 1994
Launched 12 Aug 1995
Commissioned Dec 1996

MILIUS (DDG 69)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 8 Aug 1994
Launched 1 Aug 1995
Commissioned Aug 1996

HOPPER (DDG 70)
Builder Bath Iron Works, Bath, Maine, USA
Laid down 26 Feb 1995
Launched 6 Jan 1996
Commissioned May 1997

Barry *(DDG 52), second in a class of 35 Flight I and II 'Arleigh Burke' class destroyers* (Jane's/H M Steele)

ROSS (DDG 71)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down 10 Apr 1995
Launched 22 Mar 1996
Commissioned Apr 1997

FLIGHT II

MAHAN (DDG 72)
Builder Bath Iron Works, Bath, Maine, USA
Laid down Jul 1995
Launched Jun 1996
Commissioned Oct 1997

DECATUR (DDG 73)
Builder Bath Iron Works, Bath, Maine, USA
Laid down Dec 1995
Launched Nov 1996
Commissioned Oct 1997

McFAUL (DDG 74)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down Feb 1996
Launched Jan 1997
Commissioned Mar 1998

DONALD COOK (DDG 75)
Builder Bath Iron Works, Bath, Maine, USA
Laid down Apr 1996
Launched Apr 1997
Commissioned Aug 1998

HIGGINS (DDG 76)
Builder Bath Iron Works, Bath, Maine, USA
Laid down Oct 1996
Launched Sep 1997
Commissioned Jan 1999

O'KANE (DDG 77)
Builder Bath Iron Works, Bath, Maine, USA
Laid down Mar 1997
Launched Mar 1998
Commissioned Apr 1999

PORTER (DDG 78)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down Apr 1997
Launched Mar 1998
Commissioned Apr 1999

Barry *(DDG 52). Note the Harpoon launchers below the Mk 15 Phalanx CIWS and the triple Mk 32 324 mm torpedo launchers to their left* (H and L van Ginderen Collection)

Mitscher *(DDG 57) (left) and* Russell *(DDG 59). Note the after faces of the SPY-1D radar, the neat steps on the after stack on which are mounted two SPG-62 fire-control radars and a Mk 15 Phalanx CIWS. The 61-cell Mk 41 Mod 1 Vertical Launch System is clearly visible, as is the flight deck, which can be used to refuel and rearm LAMPS-III helicopters* (Ingalls Shipbuilding)

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

McDonnell Douglas RGM-84B Harpoon

Eight Harpoon anti-ship missile canisters are mounted immediately aft of the after stack. The missiles are either Block 1B or Block 1C versions, the latter having a similar performance to the Block 1B but with certain additional options, one of which is to fly at a relatively high altitude for the first part of its path to avoid friendly ships or intervening low landmasses. A second option is to approach the target indirectly, using up to three preselected waypoints, where course can be changed at angles greater than 15°. The Block 1C missiles can also use selectable seeker search expansion patterns and, for the terminal phase have the alternatives of a sea-skimming approach or a low-apogee 'pop-up' trajectory.

Specifications

(Block 1C)
Length:
with booster: 4.63 m (15.19 ft)
without booster: 3.84 m (12.59 ft)
Diameter: 34 cm (1.12 ft)
Wing span: 83 cm (2.72 ft)
Weight:
with booster: 681.9 kg (1,503 kg)
without booster: 519.3 kg (1,145 lb)
Max speed: Mach 0.85
Range: 67 n mile (124 km)
Propulsion: Teledyne CAE J402-CA-4000 single-spool turbojet; 2.92 kN st
Booster: Thiokol or Aerojet rocket; 5,400 kg thrust for about 2.9 s
Warhead: 221.6 kg (488.5 lb) semi-armour-piercing
Fuze: Contact delay
Guidance: Inertial and active radar

Manufacturers/Contractors

McDonnell Douglas Aerospace, St Louis, Missouri, USA (prime and missile).
US Naval Weapons Center, China Lake, California, USA (warhead).
Thiokol, Elkton, Maryland, USA (booster).

BGM-109 Tomahawk

Any version of Tomahawk can be carried, two of which are for land-attack missions, one with a conventional HE warhead (BGM-109C Tomahawk Land Attack Missile — Conventional (TLAM-C)) and the other with submunitions (BGM-109D Tomahawk Land Attack Missile — D (TLAM-D)). The third type is the BGM-109B Tomahawk Anti-Ship Missile (TASM), which also has a conventional HE warhead. A fourth version, BGM-109A Tomahawk Land Attack Missile-Nuclear (TLAM-N), has been removed from ships at sea as a result of START I, but is retained in reserve ashore and the ships could quickly be recertified for TLAM-N in an emergency.

The major sub-type now in service is the Block II, although the Block IiI has been in production since 1993 and Block II missiles are being progressively brought up to the new standard. The missile is launched using a rocket booster until the turbofan engine takes over and the booster is jettisoned.

BGM-109A uses inertial navigation with terrain contour matching (Tercom), while BGM-109B uses inertial plus active radar terminal guidance, and BGM-109C/D inertial and Tercom mid-course guidance with Digital Scene Matching Area Correlation (DSMAC) for terminal guidance. Tercom stores digital terrain profile map information in the missile before launch, which is compared with radar altimeter measurements of ground elevations below the missile during a set number of sections en route to the target. The Block III upgrade programme includes a Global Positioning System (GPS) receiver to supplement or replace the Tercom system. In the terminal phase, DSMAC compares a stored digital representation of the target area with the scene viewed below the missile by a TV camera. This latter system is claimed to be extremely accurate for attacking land targets, with a circular error probable (CEP) of 10 m (32.8 ft) being reported. Both the BGM-109C and D versions have a programmable terminal dive attack mode option.
The BGM-109A is fitted with a W80 135 kg (298 lb) nuclear warhead, while the BGM-109B/C have 454 kg (1,000 lb) unitary HE warheads taken from old Bullpup B missiles. The BGM-109D has 166 combined effects BLU-97B bomblets, each weighing 1.5 kg (3.3 lb) which can be dispensed in groups against up to four separate targets.

Block III missiles have a more powerful and more fuel-efficient turbofan engine, which, coupled with increased fuel capacity, results in a range increase of at least 30 per cent. The BGM-109C Block III missiles have a smaller WDU-36B 320 kg (700 lb) warhead carrying a unitary HE charge with a selectable fuze delay to increase warhead penetration before detonation.

Specifications

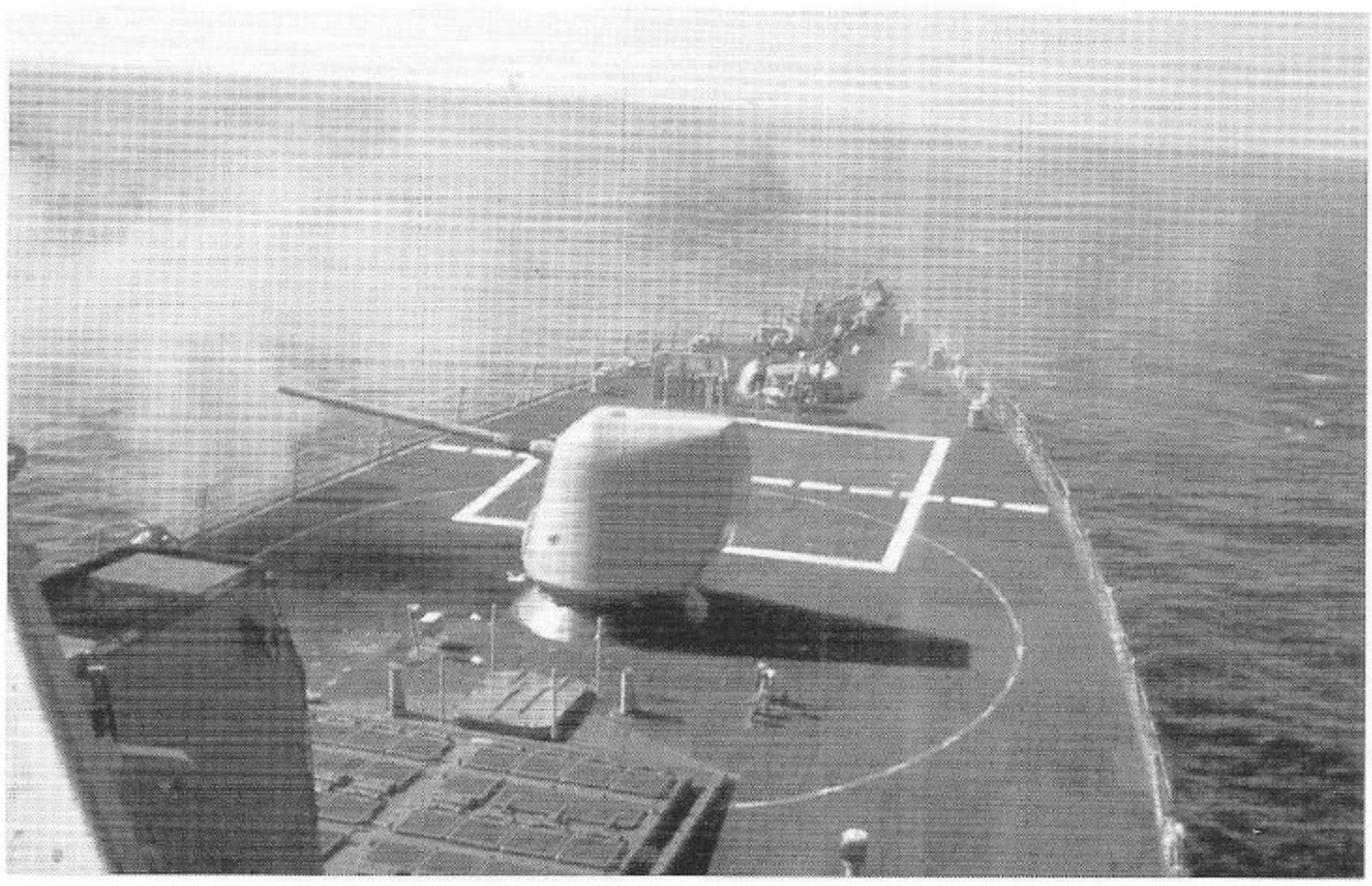
Designation	BGM-109B	BGM-109C	BGM-109C	BGM-109D
Mission	Tomahawk anti-ship missile (TASM)	Tomahawk land-attack missile — conventional (TLAM-C)	Tomahawk land-attack missile — conventional (TLAM-C)	Tomahawk land-attack missile — D (TLAM-D)
Airframe standard	Block II	Block II	Block III	Block II
Length	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)
Diameter	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)
Wing span	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)
Launch weight	1,452 kg (3,201 lb)	1,452 kg (3,201 lb)	n/k	1,452 kg (3,201 lb)
Warheads	454 kg HE (1,000 lb)	454 kg HE (1,000 lb)	320 kg HE (705 lb)	166 bomblets
Range	240 n miles (450 km)	490-700 n miles (900-1,300 km)	1,000 n miles (1,857 km)	490 n miles (900 km)
Accuracy — circular error probable (cep)	n/a	10 m (33 ft)	10 m (33 ft)	10 m (33 ft)
Speed	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)
In-service date	1983	1983	1993	1989
Engine	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR402 turbofan (335 kg thrust)	Williams International F107-WR400 turbofan (272 kg thrust)
Number currently on order	593	1,486	n/k	1,157

Notes
BGM-109A (TLAM-N) is not listed as it is not deployed in operational ships, but it should be noted that it remains in reserve ashore

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA (prime).
McDonnell Douglas Missile Systems, St Louis, Missouri, USA (second source).

SURFACE-TO-AIR MISSILES (SAM)

There are two Guided-Missile Vertical Launch Systems (GMVLS):
Forward: one GMVLS Mk 41 Mod 0 29-cell unit
Aft: one GMVLS Mk 41 Mod 1 61-cell unit



Arleigh Burke *(DDG 51) fires its 127 mm (5 in)/54 Mk 45 gun* (US Navy)

These are used to launch Standard SM-2MR SAMs, VLA ASROC and Tomahawk missiles. GMVLS Mk 41 Mod 2 is fitted from DDG 59 onwards. There are actually 32 and 64 cells respectively, but in each group there is an at-sea reloading system which takes up three cells.

Standard Missile-2 Medium Range (SM-2MR) Block 4
The Arleigh Burke Flights I and II carry Standard SM-2MR Block IV, which can be used for surface-to-air (including passive home-on-jam) and surface-to-surface engagements. The propulsion section uses the Thiokol Mk 104 dual thrust rocket motor with ARC acting as second source. The SM-2 missile's course is controlled from the ship by means of an RF link until the target comes within the missile seeker's field of view. This system allows the use of the ship's search radar to provide missile launch data and, by shaping the missile flight path into an energy-efficient trajectory the effective range of the system is doubled.

Specifications
(SM-2MR)
Length: 4.72 m (15.49 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.06 m (3.47 ft)
Weight: 706.7 kg (1,558 lb)
Speed: Mach 2.5
Range: 37.75 n miles (70 km)
Altitude: 19,800 m (65,000 ft)
Guidance: Semi-active radar homing

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA.
Raytheon Missile Systems Division, Bedford, Massachusetts, USA.

ANTI-SUBMARINE MISSILES

RUM-139 Vertical Launch ASROC (VLA) anti-submarine missiles
VLA is a three-stage ASW weapon launched from the Mk 41 GMVLS and controlled by the Mk 116 Mod 6-8 fire control system. The current version of VLA carries the Mk 46 Mod 5 torpedo, but this will be changed, in due course, to the Mk 50 Barracuda. The torpedo is mated to the Mk 11 Mod 0 airframe assembly which houses the remainder of the missile. The assembly forms the first stage flight vehicle and consists of an upper and lower airframe which are tapered to reduce drag and have two trapezoidal fins each, to provide aerodynamic stability. The airframe assembly houses a two-stage, ribbon-type parachute which provides aerodynamic stability to the torpedo when it separates from the airframe and also slows it so that it will not disintegrate upon entering the water. The nose of the torpedo is covered by an ogive-shaped nose cap to protect it as it penetrates the cover of the canister and later as it enters the water. The missile is powered by a rocket motor with a thrust vector control, which consists of four jet vanes in the nozzle extension and leads to turnover during the boost phase of the flight.

When the target has been located the Mk 116 ASW fire control system provides launch orders and automatically selects and initiates a missile, while target location details are entered through the Mk 41 GMVLS launch control unit. The missile is then launched and the booster propels it out of the silo, whereupon the thrust vector control turns it towards the target. Thrust cut-off takes place at a time appropriate to the commanded range and the booster separates and falls away, leaving the missile to follow a ballistic path. As the missile descends, the airframe assembly is discarded, the ribbon parachute is deployed and the nose-cap's steel tip is carried away. As the torpedo enters the sea, water pressure in the cavity of the nose cap causes the cap to disintegrate and the impact causes the parachute release mechanism to operate, allowing the torpedo to begin the search phase.

Specifications
VLA
Length: 4.89 m (16.04 ft)
Diameter: 35.81 cm (15.1 in)
Span: 69.6 cm (27.4 in)

Weight: 639.12 kg (1,409 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9
Limiting sea state: Sea State 6

Manufacturers/Contractors

Honeywell Inc, Training and Control Systems Operations (ASROC).
Loral Systems Group (VLA prime).
Martin Marietta (VLA second source).

Specifications — torpedoes

	Mk 46 Mod 5	Mk 50
Diameter	324 mm (12.75 in)	324 mm (12.75 in)
Length	2.95 m (9.68 ft)	2.89 m (9.48 ft)
Weight	230 kg (507 lb)	363 kg (800 lb)
Speed	40 kts	55-60 kts
Range	6 n miles (11.2 km)	10.75 n miles (20 km)
Homing	active/passive acoustic homing	
Warhead	Mk 103 Mod 1; 44 kg; PBXN-103	45 kg shaped charge HE
Motor	5-cylinder liquid mono-propellant (Otto) motor	closed-cycle

Manufacturer/Contractor

Loral Defense Systems, Akron, Ohio, USA (Mk 46).
Alliant TechSystems Inc, Marine Systems.
Westinghouse Electronic Corporation, Naval Systems Division (Mk 50).

TORPEDOES

324 mm Mk 32 triple torpedo launchers

Two triple Mk 32 torpedo launchers are mounted, one on either beam, on the weather deck, abreast the after VLS launchers.

Mk 46 Mod 5/Mk 50 torpedoes

See VLA entry (above) for details.

GUNS

Mk 45 Mod 1/2 single 127 mm (5 in) L/54 gun mounting

One United Defense single 127 mm (5 in) Mk 45 Mod 1/2 gun is mounted forward, firing semi-fixed ammunition with point detonating, proximity (variable time or infra-red), mechanical time and electronically set fuzes. The theoretical rate of fire is 20 rounds per minute and a gun crew of six is required, all below decks, of which four are ammunition handlers. The Mod 1 incorporates a number of improvements over the Mod 0, including the ability to change the type of ammunition under remote control and electronic fuze setting.

Specifications

Calibre: 127 mm (5 in)

Bow view of Ramage *(DDG 61). Note SLQ-32(V)2 on small platform below bridge wing.* (Ingalls Shipbuilding)

Length of barrel: 54 calibres
Muzzle velocity: 807.72 m/s (new barrel), 762 m/s (mid-life) (2,649-2,499 ft/s)
Crew: 6 (1 mount captain, 1 panel operator, 4 ammunition handlers)
Traverse: 340° at 30°/s
Elevation: −15 to +65° at 20°/s
Range:
anti-ship: 12.39 n miles (23 km)
anti-air: 15,000 m (49,000 ft)
Rate of fire: 16-20 rds/min
Ammunition weight: 31.75 kg (70 lb) (projectile)

Manufacturer/Contractor

United Defense, Armament Systems Division, Minneapolis, Minnesota, USA.

Hughes Mk 15 CIWS Phalanx

Two Hughes Mk 15 Phalanx Close In Weapons Systems (CIWS) provide the innermost layer of defence against anti-ship missiles. One mount is located on a small platform immediately before the bridge screen, the other is atop the after deckhouse, above the Harpoon launchers. Each mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds. These mounts are being fitted with IR detectors to enable them to track small boats.

Specifications

Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturer/Contractor

Hughes Missile Systems, Tucson, Arizona, USA (system).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

AN/SLQ-32(V) ESM Suite

As built, DDG 51 to DDG 71 had the AN/SLQ-32(V)2 EW suite, while DDG 72 onwards have the AN/SLQ-32(V)3 suite. AN/SLQ-32(V)2 gives radar warning on B to J-bands, while (V)3 not only gives radar warning on B to J-bands, but adds extra antenna arrays and electronics to give jamming and deception on H to J-bands.

Previous plans to upgrade AN/SLQ-32(V)2 to (V)3 have been discarded; instead, those ships with SLQ-32(V)2 are being upgraded to SLQ-32(V)5 standard by adding the Raytheon Sidekick. Sidekick provides active onboard countermeasures, employing a high gain, multibeam antenna system and has a full ECM techniques repertoire for both ship defence and counter-targeting roles. System software is a modification of that used with AN/SLQ-32(V)3. Sidekick can counter simultaneous threats from any azimuth angle.

The AN/SLQ-32(V)3 is essentially AN/SLQ-32(V)2 plus an AECM (Active Electronic CounterMeasures) mode, which can be operated semi-automatically, where the operator initiates jamming against a given emitter, or automatically under computer control, where the system initiates countermeasure action as soon as a threat is identified, generating an appropriate response in the required direction, with the computer scheduling transmissions, so that multiple targets can be countered simultaneously.

Manufacturer/Contractor
Raytheon Company, Electromagnetic Systems Division, Goleta, California, USA.

AN/SRS-1 COMBAT DF shipboard signal exploitation system
From DDG-72 onwards, ships are fitted with the AN/SRS-1 Combat shipboard digital signal exploitation system, whose main use is in obtaining targeting information for Tomahawk missiles. It is based on a distributed architecture concept and incorporates high-speed signal processing for demodulation, analysis and recognition of a wide variety of both conventional and spread spectrum communications signals.

Manufacturer/Contractor
Lockheed Sanders Inc, Nashua, New Hampshire, USA.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher
There are two Mk 36 Mod 12 SRBOC (Super Rapid Bloom Offboard Countermeasures) units, with one mounted on a small platform either side of the forward stack.

Specifications
Launcher
Dimensions: 160 × 43 × 86 cm (6.3 ×17 × 34 in)
Weight: 173 kg (381.4 lb)
Range: 4 km (2.2 n miles)

Rounds
Mk 182: 1,209 × 130 mm; 22.7 kg
Super Chaffstar: 1,209 × 130 mm; 20.9 kg
Super Gemini: 451 × 130 mm; 5.5 kg
Super Hiram III: 1,220 × 130 mm; 13.6 kg
Super Hiram IV: 467 × 130 mm; 3.8 kg
Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturers/Contractors
Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

AN/SLQ-25 Nixie noisemaker
The AN/SLQ-25 Nixie is a solid-state, modular design electro-acoustic countermeasures decoy system used to protect the carrier from acoustic homing torpedoes. It consists of a remote-control unit which activates, deactivates and monitors the system, a countermeasures transmitter which generates and amplifies the signals, a power-operated double-drum winch for streaming/recovering the towed bodies and a coaxial switching unit which selects the appropriate cable or load and towed bodies. The towed bodies convert the electrical signals to acoustic signals and project them while other elements of the system include three electronic dummy loads for testing the amplifier without streaming a towed body. The winch and two towed bodies are located in a stern compartment, with the towed bodies being deployed through the transom or in a partially or totally enclosed location on the main deck. Immediately forward of the winch compartment is the Nixie electrical room where the winch motor controller, the coaxial switching unit dummy loads, and the transmitter are located. Each winch can stream and recover the 487.5 m (1,599 ft) of cable at 30.5 m/min (100 ft/min), each cable weighing 408.24 kg (900 lb). The towed bodies, streamlined to prevent cavitation and with all exposed aluminium parts anodised for corrosion resistance, are 94.6 cm (37 in) long, 15.24 cm (6 in) in diameter and weigh 18.14 kg (40 lb). They receive amplifier outputs, convert them into acoustic signals and project them. Usually one towed body at a time is deployed.

Manufacturer/Contractor
Aerojet ElectroSystems, Sacramento, USA.

NATO Sea Gnat
NATO Sea Gnat is a long-range chaff/infra-red (IR) decoy launching system for NATO warships and consists of a control unit, a launcher with 130 mm tubes and munitions. The control unit provides for the launching of the most effective combination of rounds for distraction and centroid/seduction given the type, speed and direction of the threat, the ship's speed and heading as well as wind direction and speed. There are three types of round:
Mk 214 RF seduction
Mk 216 RF distraction
Mk 218 IR seduction.

Manufacturers/Contractors
THORN EMI/AB Precision Ltd, UK (control unit).
Hunting Engineering, UK (launchers).
Chemring Ltd, UK (munitions).

AN/SLQ-39
AN/SLQ-39 is a chaff-dispensing buoy.

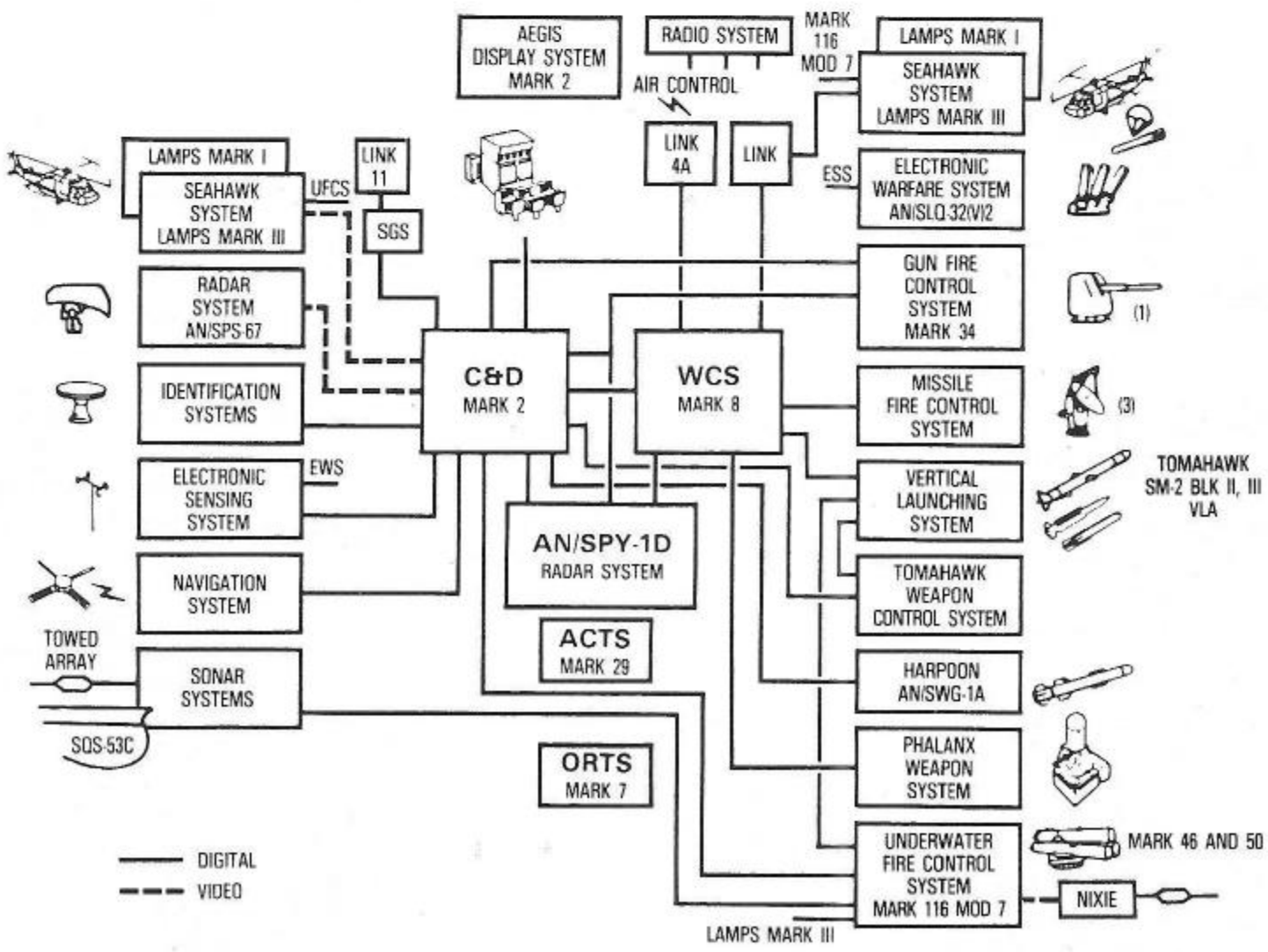
AN/SLQ-95 AEB
AN/SLQ-95 is an Active Expendable Buoy (AEB) designed to disrupt hostile communications systems.

COMMAND AND CONTROL SYSTEMS

COMBAT DATA SYSTEMS

ACDS Block 1
Advanced Combat Direction System (ACDS) is an enhanced version of the Naval Tactical Data System (NTDS) tactical data handling and target designation system. CVNs have been fitted with ACDS Block 0, but the 'Arleigh Burke' class destroyers are receiving ACDS Block 1, which has enhanced capacity, features new command, communications, control and information interfaces and provides Link 16 facilities, as well as the previous Links 4A, 11 and 14. The Block 1 system includes three AN/UYK-43B processors; one each for track management, decision support, and command and control. Block 1 can also interface with the Naval tactical Command System — Afloat. A Block 2 system was planned, but has been cancelled.

Manufacturers/Contractors
Unisys (computers).
Hughes Aircraft Company (displays).
Collins (communications).



Aegis command and weapon system as installed in 'Arleigh Burke' class destroyers. Sensors are on the left and weapons system on the right

COMMUNICATIONS AND DATALINKS

These ships have a very comprehensive communications fit, including:
SRR-1 Satcom
WSC-3 (UHF)
USC-38 (EHF)
SQQ-28 datalink for LAMPS III
TADIXS B Tactical Data Exchange System (installed in DDG 72 onwards, TADIXS B is a data exchange system for electronic intelligence (ELINT))
Link 4A
Link 11
Link 14
Link 16 (from DDG 72 onwards).

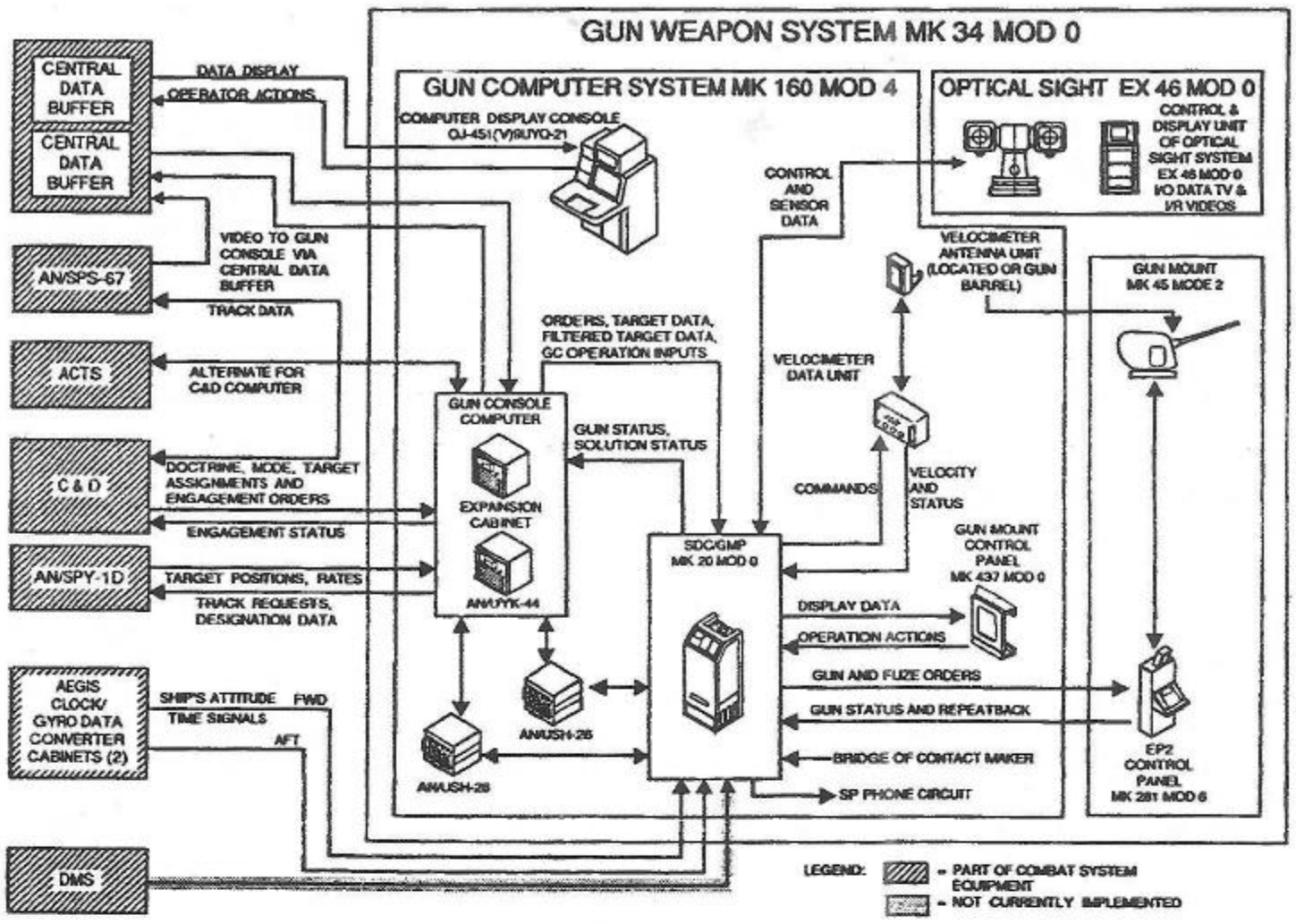
WEAPONS CONTROL

Aegis Mk 7 command and weapon system
The Aegis system consists of four federated subsystems supported by the Aegis Operational Readiness Test System (ORTS) with a single computer. In the 'Arleigh Burke' class destroyers the subsystems, each backed by four AN/UYK-43B 32-bit computers, are:

(a) AN/SPY-1D multifunction radar
(b) The Command and Decision System (CDS) Mk 2
(c) The Aegis Display System (ADS) Mk 2
(d) The Weapon Control System (WCS) Mk 8

The Aegis system has four operating modes; automatic, automatic special, semi-automatic and casualty. The automatic special mode ensures that targets which meet predetermined threat criteria will be automatically engaged unless the order is overridden manually. The other modes are self-explanatory but in all of them the firing is initiated manually.

AN/SPY-1D
The prime sensor is the Lockheed Martin (formerly Martin Marietta; formerly GE Aerospace) AN/SPY-1D, an E/F-band (2-4 GHz) multifunction radar which conducts



Gun Fire Control System Mk 34 Mod 0 is an integral part of the Aegis Mk 7 command system

horizontal and hemispherical searches and is capable of tracking and designating multiple targets. The radar also acts as a two-way link with missiles for mid-course guidance when instructed to do so through the weapon control system. The four antennas, each measuring 3.65 × 3.65 m (12 × 12 ft) are installed in the forward superstructure at an angle of approximately 45° and maintain accurate co-ordination even if the ship is moving ±30° in roll and ±15° in pitch. They provide hemispherical coverage from a single transmitter and a signal processor controls the high power, ultra-precision, high temperature resistant garnet phase shifters which integrate microwave and electronic hardware. There are 4,100 phase shifters in each antenna, which steer the beam to cover the sectors and designated targets, although some phase shifters are also used to eliminate sidelobes.

AN/SPS-67(V)3

The SPY-1D radar is complemented by two dedicated radars: the Norden AN/SPS-67(V)3 G-band (4-6 GHz) surface search radar and the AN/SPS-64(V)9 navigation radar. The AN/SPS-67(V)3 surface search radar retains the open lattice construction, horn feed antenna of its predecessor, the AN/SPS-10, and operates in narrow (0.1 µs), medium (0.25 µs) and long (1 µs) pulse modes for detecting targets in the open sea (2400, 1200, 750 pps respectively). Performance is further improved by a digital video clutter suppressor and an interference suppressor. The version used in the 'Arleigh Burke' class, SPS-67(V)3, provides digital moving target indicator, automatic target detection and track-while-scan capabilities to improve naval gunfire support in association with the Mk 34 fire-control system.

AN/SPS-64(V)9

AN/SPS-64(V)9 is an I-band Raytheon navigation radar. It is widely used within the US armed forces, with (V)9 being a version specially designed for the US Navy.

CDS Mk 2

The Command and Decision System Mk 2 provides overall operational direction and co-ordination. It receives data from onboard sensors and also from offboard sensors via Link 11, Link 14, and later also Link 16 (JTIDS). CDS is used to help assess threats and to assign engagement instructions to the WCS. In addition to inputs from radar and sonar sensors it also receives inputs from the AN/SLQ-32(V) electronic warfare suite (see above). CDS Mk 2 also receives further direct inputs from the AN/SQQ-89 sensors both onboard through the Mk 116 fire-control system and offboard from the Light Airborne MultiPurpose System III (LAMPS III) ASW helicopter datalink.

GFCS Mk 34 Mod 0

The integral Mk 34 Mod 0 Gun Fire Control System (GFCS) interfaces directly with the CDS through its AN/OJ-451(V)9 console. The Mk 34 has a Unisys Mk 20 signal data converter/gun mount processor which accepts data from the AN/SPY-1 and AN/SPS-67 radars as well as the Mk 46 electro-optic sight, velocimeter. Gun and solution status statements are then made to the Mk 160 Mod 4 gun computing system which provides target data to the Mk 20 which in turn provides the gun with orders and fuze instructions.

ADS Mk 2

The Aegis Display System (ADS) Mk 2 consists of two computer-driven large screen (1.06 × 1.06 m) (3.47 × 3.47 ft) displays with processed data and automated status boards which in later ships are replaced by similar central alphanumerics generators. It allows the ship's commander, his tactical action officer and the task group commander (if embarked) to assess the operational situation and to issue orders both to onboard and offboard weapon systems and units. ADS control consists of two Mk 123/124 Advanced Large Screen Display Controllers and an AN/OJ-471 console for each pair of screens. Within the CIC are some 18 consoles including an AN/SPG-25 for navigation radar. Supporting the Aegis system are consoles for sensor control including those for the radar system supervisor, radar track manager and ESM manager, for weapon control with consoles for the anti-air warfare co-ordinator, missile engagement controller, two air intercept controllers and fire-control system supervisor. There is a four-console anti-submarine warfare team and one for surface warfare. The remaining consoles are for the AN/SWG-3A fire-control system used with Tomahawk surface-to-surface missiles, the AN/SWG-1A used with the Harpoon anti-ship missile, the Mk 86 Mod 9 gun fire control system and the AN/SLQ-32 electronic warfare suite.

WCS Mk 8

The Mk 8 Aegis WCS (Weapon Control System) is for the engagement of targets in the air, on the surface and underwater, although the priority is given to engaging air targets. The system interfaces with sensors of various onboard systems and offboard systems with direct links to the LAMPS ASW helicopter and through Link 4A to aircraft. The system receives engagement instructions through the CDS and selects the appropriate weapons system and weapon. It schedules targets, issues firing orders and controls surface-to-air missiles launched by the Mk 99 fire-control system until they are close to the interception point.

The WCS interfaces with several fire-control systems and the Phalanx CIWS. The fire-control systems are the Mk 34 gun fire control system to support the 5 in (127 mm) gun, the Mk 116 Mod 7 anti-submarine system, the AN/SWG-1A (Harpoon) and AN/SWG-3A (Tomahawk), the LAMPS Mk III ASW helicopter, the missile launching system (Mk 26 or Mk 41) and the Aegis integral surface-to-air missile fire-control system, the Mk 99 Mod 3.

MFCS Mk 99 Mod 3

The Missile Fire-Control System (MFCS) Mk 99 generates director and launcher commands for the three slaved AN/SPG-62 illuminator radars which are also used to provide target illumination for missiles from other ships. The Mk 99 selects the missile engagement mode then acquires and tracks the target using uplink mid-course command guidance through the AN/SPY-1, which generates continuous targeting data, to guide the missile close to the target which is then illuminated by the AN/SPG-62s for the terminal phase.

SWG-3 Tomahawk WCS

SWG-3 is the weapon control system for the Tomahawk missile.

AN/SWG-1A Harpoon Launch Control System (LCS)

SWG-1A is the Harpoon Launch Control System, which activates the missile, selects the flight pattern and sets seeker search modes (with small, medium or large acquisition windows), as well as providing target range and bearing data. Alternatively, the missile can simply be launched along the bearing of the target, with the seeker activated early to scan a 90° sector; if, after a set time, no target has been acquired, the missile commences a preset search pattern. SWG-1A takes account of other ships in the general target area and generates indirect flight plans for the missile, including waypoints to optimise angles of approach which will achieve the highest possibility of success while minimising the chances of the missile being destroyed by hostile fire. It can also be used to compute flight plans in a multiple attack so that several missiles, from either the same or different ships, arrive on target simultaneously, thus swamping the defences.

AIMS AS-3134/UPX-29

AIMS is the IFF component of the Aegis system. The array consists of 64 elements each 40 cm (15.74 in) high arranged in a circle 3.8 m (12.5 ft) in diameter which are scanned electronically, enabling return signals to be localised with an accuracy of less than 3°.

Manufacturers/Contractors

Martin Marietta, Government Electronic Systems (Aegis prime and SWG-1A).
Unisys (computers).
Computer Sciences Corporation (software).
Hughes Aircraft Company (displays).
Raytheon (Mk 99 fire control system).
Lockheed (AIMS).

SONARS

The anti-submarine warfare system comprise the Mk 116 Mod 7 ASW fire-control system, the AN/SQQ-89(V)6 combat system and a sonar suite consisting of AN/SQS-53C bow-mounted sonar array, the AN/SQR-19 (TACTAS) towed array, and the AN/SQQ-28 SSPS which processes data received from the LAMPS I/III helicopter.

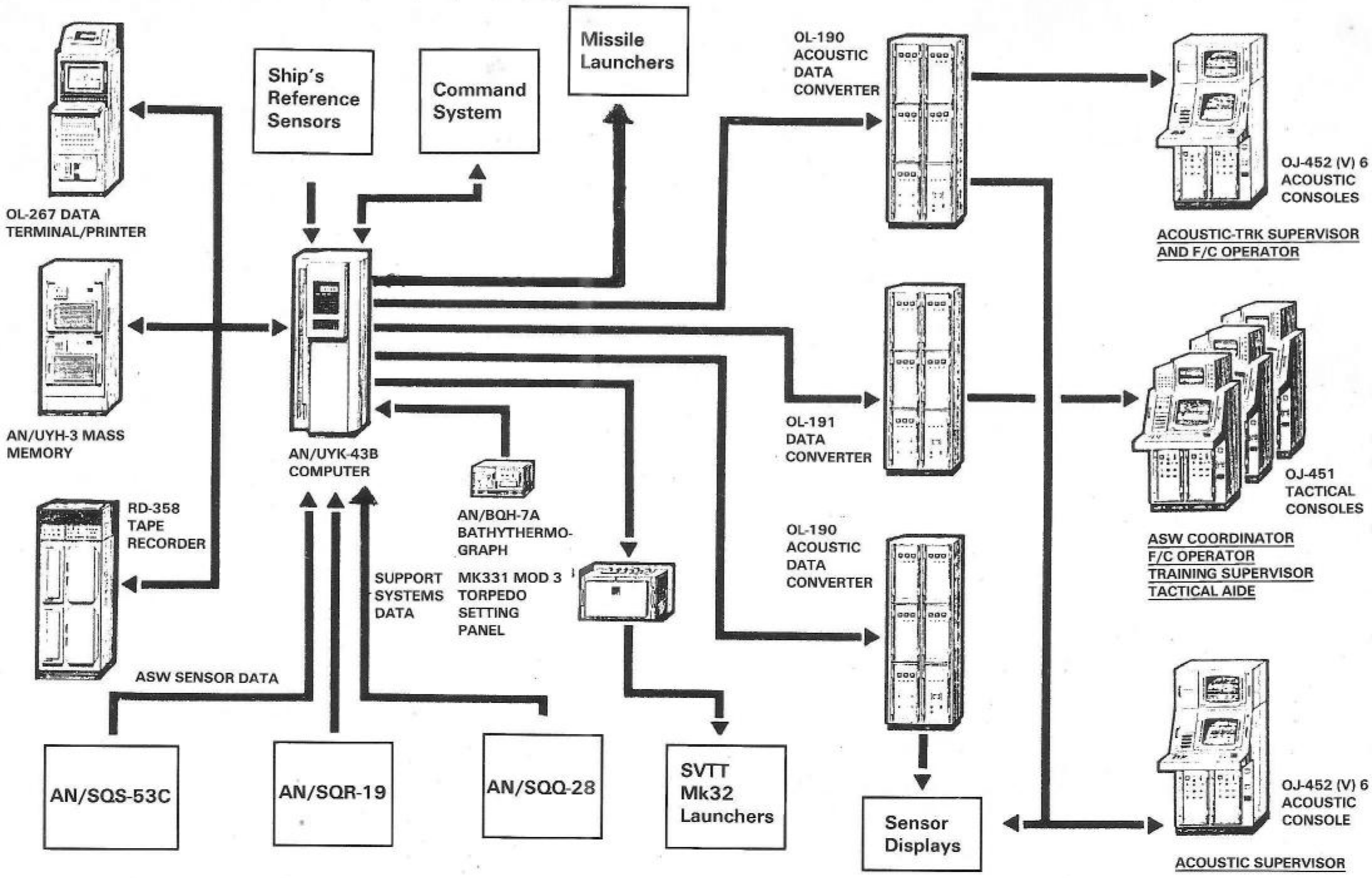
Kingfisher mine avoidance sonar in some.

Mk 116 Mod 7 anti-submarine fire-control system

The Mk 116 underwater fire-control system is designed to provide tactical data processing, contact management, target engagement processing and weapon fire control and consists of two elements: the Computer Processing Subsystem (CPS) and the Weapon Control and Setting Subsystem (WCSS). Data are also received from external sensors and distributed around the system by an integral switchboard or data converter.

The CPS provides displays of tactical data, computes and stores track data, calculates weapon control firing solutions for selected targets and generates weapon recommendations and launcher orders. The Mod 7 system in the 'Arleigh Burke' class is based upon two AN/UYK-43B computers, each of which has two Central Processing Units (CPU) with a memory of 2,560,000 words and an optimum processing power of 3 Mops. The US Navy's own CMS-2 computer language is used.

The WCSS consists of the Mk 329 weapon control panel which selects the fire-control mode, the sensor-weapon pairing, weapon and launcher, torpedo



Mk 116 Mod 7 anti-submarine fire-control system

presetting and then launches the weapon. The external sensors all include an electromagnetic log and the Type F wind indicator. The other sensors and the data distribution unit are tabulated alongside. These elements of the WCSS are the same as in other versions of the Mk 116, except that the Mod 7 (the version used in the 'Arleigh Burke' class) has a different display system and data converter.

Manufacturer/Contractor

Loral Librascope.

AN/SQQ-89(V)6 anti-submarine combat system

The AN/SQQ-89(V) surface ship anti-submarine warfare combat system detects, locates, tracks and engages submarine targets, which transmit and/or receive acoustic signals using a variety of sensors. Received signals are processed to provide target classification as well as performing TMA and controlling the setting of own-ship ASW weapons. In addition it provides multisensor track correlation, track management control and forwards track data to ship's Combat Direction System (CDS) or Command and Decision System (C&DS). The system is an integrated combat system consisting of sonar sensors which interface with the Mk 116 fire control system to provide maximum operational effectiveness combined with minimum manpower requirements.

In the Arleigh Burke class Flights I and II, the sensors integrated in AN/SQQ-89(V) are the AN/SQS-53C hull-mounted sonar, AN/SQR-19(V) Tactical Towed Array Sonar (TACTAS), and the AN/SQQ-28 LAMPS I/III Sonar Signal Processing System (SSPS). These are supported by the AN/UYQ-25 Data Processing System (DPS) and its associated Sonar In-situ Mode Assessment System (SIMAS) computer program.

AN/SQS-53C

The prime sensor is the bow-mounted, low-frequency AN/SQS-53C active/passive sonar, which has a cylindrical array 1.6 m high (5.2 ft) and 4.8 m (15.7 ft) in diameter with 576 transducers. The sonar is reported to have an active transmitting frequency of about 3 kHz and a peak frequency of 192 kHz. SQS-53 operates in three active modes; surface duct, bottom bounce and convergence zone, and ranges are reported to be approximately 10 n miles (18.5 km) in surface duct mode and up to 34.5 n miles (64 km) in convergence zone mode. Passive detection range is reportedly greater than the previous SQS-26 with the ship capable of operating at higher speeds, which helps to give the system a multiple target tracking capability.

The SQS-53C is an upgraded version of SQS-53B which can detect, classify and locate both subsurface and surface targets using active and passive means. It consists of four major subsystems, the array, the transmitter, the receiver and the control/display. AN/SQS-53C is electronically embedded in the AN/SQQ-89 combat system.

AN/SQR-19(V)

The AN/SQR-19(V) towed sonar array is a passive, long-range omnidirectional system for detecting and classifying submarine targets. Its OA-9056/SQR-19 towed array group consists of an array 244 m (800 ft) long and 82 mm (3.2 in) in diameter, which is towed on a 1 n mile (1.85 km) cable. The array can reach depths of up to 365 m (1,200 ft), but is so designed that it can achieve this without needing a 'fish' to depress it. The other two major subsystems are the Ship-based Electronic Subsystem (SES) and the OK-410/SQR-19 Handling and Stowage Group (H&SG). Early versions of AN/SQR-19 use the AN/UYK-20 Data Processing Set (DPS) but systems produced from FY87 onwards use the AN/UYK-44-based Signal Data Processing Unit (SDPU).

AN/SQQ-28(V)9 SSPS

The AN/SQQ-28 Shipboard Sonar Processing System (SSPS) is the shipboard processor for the LAMPS III weapon system. It processes raw data from the sonobuoys laid by Sikorsky SH-60B Seahawk LAMPS IIIA SW helicopters which are relayed to the ship via the AN/SQR-4 duplex digital link and received by the AN/ARR-75 receiver. LAMPS I acoustic data, from sonobuoys laid by the Kaman SH-2F Seasprite, can also be received using the AN/SKR-4B(V) receiver. Modifications to the SKR-4 interface allow LAMPS I and LAMPS III interoperability, and shipboard sonobuoy receiver set or training acoustic inputs to the datalink port of the AN/SQQ-28 Input Signal Switching Unit (ISSU). When SQQ-28 is installed in ships with the AN/SQR-19, it shares the DPS or the SDPU. The AN/UYQ-25A(V)2 DPS and the associated SIMAS provide a computer-based capability for sonar in-situ performance prediction and mode selection to provide the most effective AN/SQQ-89 system performance in various environmental conditions.

AVIATION

AVIATION FACILITIES

Specifications

Flight deck: There is a landing platform and facilities to fuel and rear in LAMPS III SH-60B/F helicopters

Hangar: There is no hangar

Tacan: URN 25

PROPULSION

Specifications
System: Combined gas turbine and gas turbine (COGAG)
Main machinery: 4 General Electric LM-2500 gas turbines; 78.33 MW (105,000 hp) sustained
Shafts: 2
Propellers: cp

FURTHER INFORMATION

PROGRAMME

The 'Arleigh Burke' class was conceived in the early 1980s as a replacement for the 'Charles F Adams' (DDG 2) and 'Coontz' (DDG 40) classes of missile destroyers, which had entered service between 1959 and 1964, and were due to reach 'block obsolescence' in the early 1990s. At the time they were conceived, the Arleigh Burkes were intended to complement the Aegis cruisers in support of 15 carrier battle groups (CVBG) and the four Surface Action Groups (SAG), although the latter no longer exist with the withdrawal from service of the 'Iowa' class battleships. The Arleigh Burkes were also intended to escort replenishment and amphibious groups. The first of class was authorised in FY85 and was laid down in 1988, joining the fleet in 1991.

The first 21 ships (DDG 51 to DDG 71) constitute the basic design, known as Flight 1. The next seven incorporate some relatively minor changes and are designated Flight II. It was then intended to produce a major development, Flight III, but this was dropped when the end of the Cold War resulted in major reductions in funding. Instead, production has switched to Flight IIA, although, as described below, the differences between Flight IIA and Flight II are considerably greater than between Flight II and Flight I.

DESIGN

The design of the 'Arleigh Burke' class was finalised in the mid-1980s and thus one of the many influences was the recent (1982) naval conflict in the Falklands (Malvinas) war.

Stethem *(DDG 63). Sensors visible are from the top of the mast: LAMPS-III datalink (wrapped around topmast), URN-25 TACAN (on platform); SPS-67(V)3 surface search (on lower yardarm); SPS-64(V)9 navigation (small platform on side of visit); SPG-62 fire-control radar (on bridge roof). Also on the bridge roof are two satellite antennas. On the bridge face are two of the four planar arrays of the SPY-1D system*

The hull was a totally new design and is noticeably 'beamier' than in previous US Navy ship classes; the 'Ticonderoga' class, for example, has a beam length ratio of 1:10.3, whereas that in the 'Arleigh Burke' class is 1:7.5. This has resulted in a very flat waterplane enabling the designers to avoid the use of fin stabilisers and the ships have shown a notable ability to maintain high speed in very adverse weather. Greater power is, however, required to drive the hull through the water and the LM 2500 gas turbines have been upgraded from 21,500 shp each in the 'Spruance' class to 26,250 shp each in the 'Arleigh Burke' class, a 22 per cent increase in power.

The ships are constructed entirely of steel, except for the stacks which are constructed of aluminium alloy. Great attention has been paid to 'stealth' and all exposed surfaces are angled and corners rounded to reduce the Radar Cross Section (RCS). In addition, the original upright, four legged mast design was changed to a composite tripod, possibly to increase separation between electronic systems and the forward funnel, but more likely to reduce RCS. There is IR signature suppression and the Prairie/Masker systems are fitted to suppress hull noise and blade signatures.

Great attention has also been paid to resistance to battle damage. The CIC is located within the hull at main deck level as is the communications centre, while the sonar room is separated and sited well forward. Distributed data processing has been adopted to enhance survivability and vital spaces are protected by 70 tonnes of Kevlar armour. All electronics and wiring are protected against Electro-Magnetic Pulse (EMP). All accommodation compartments have sprinkler systems.

This is the first class of US Navy warship designed with a collective protection system for defence against NBC fallout. The ship's crew is protected by double air-locked hatches, fewer accesses to the weatherdecks and positive pressurisation of the interior of the ship to keep out contaminants. All incoming air is filtered and greater reliance is placed on recirculating the air inside the ship.

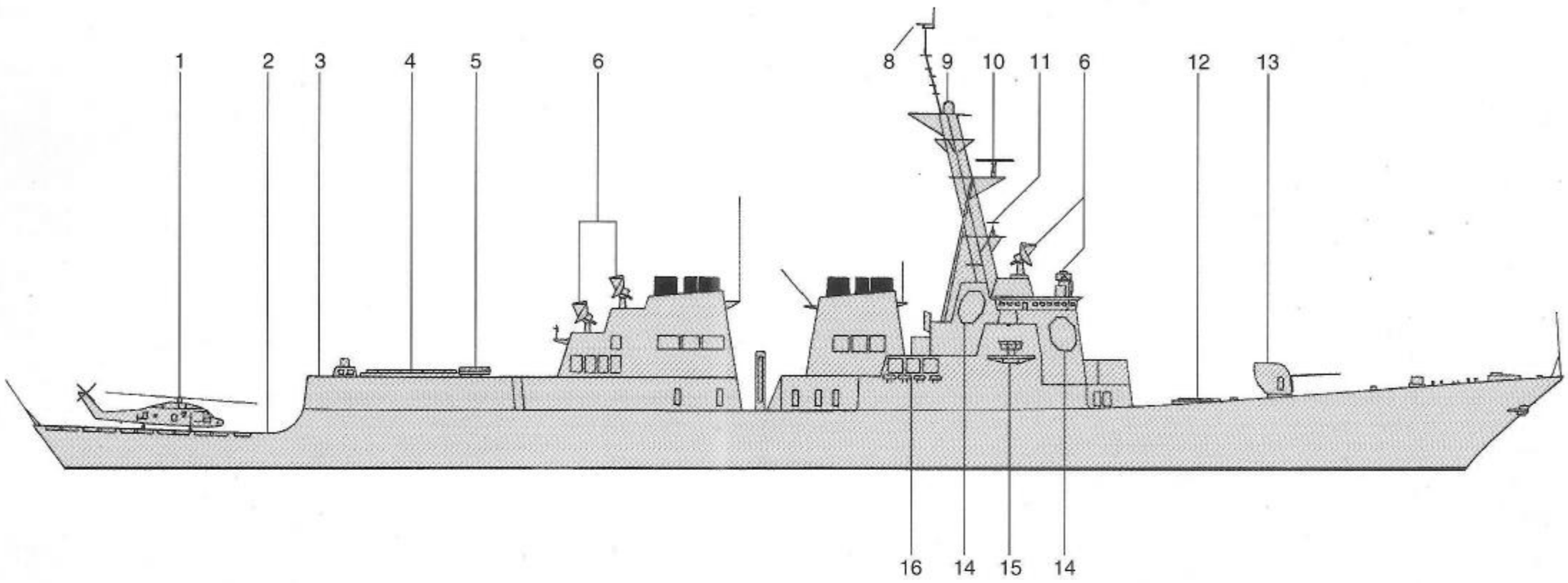
The differences in Flight II, which started with DDG-72 include the installation of Link 16, the AN/SLQ-32(V)3 EW suite, and extended range SAM (SM-2ER) missiles and improved tactical information exchange systems. There is also an increase in displacement caused by using more space to carry fuel.

Flights I and II ships lack a helicopter hangar, although they do have a flight deck with a RAST, together with a LAMPS datalink and sonar data processing facilities. The omission of a hangar has been a source of adverse comment and the major development in Flight IIA ships is the installation of a hangar. There were several reasons for the original decision, one of which was that ships they replaced had no helicopter facilities at all. In addition, at the time they were designed it seemed improbable that there would be sufficient LAMPS III helicopters for there to be one for every escort in the fleet.

NAMES

The ships bear the names of distinguished US Navy officers and sailors. *Hopper* (DDG 70) is unusual in that it is the first US Navy ship to bear the name of a woman since the Second World War. The late Rear-Admiral Grace M Hopper, USN, was one of the world's leading computer and software pioneers, and was one of the guiding lights in the development of the COBOL programming language.

ARLEIGH BURKE (Flight IIA)



Sir Winston Churchill (Ian Sturton)
1 *SH-60B LAMPS-III helicopter* **2** *Flight deck* **3** *Twin hangar* **4** *GMVLS Mk 41 Mod 0 (64 missiles)* **5** *Triple Mk 32 324 mm torpedo launcher* **6** *SPS-62 fire-control radars* **7** *Chaff launchers* **8** *LAMPS-III datalink antennas* **9** *URN-25 TACAN* **10** *SPS-67(V) radar (surface search)* **11** *SPS-64(V)9 radar (navigation)* **12** *SMR2S Mk 41 Mod 0 (32 missiles)* **13** *127 mm (5 in)/54 Mk 45 gun* **14** *SPY-1D planar array* **15** *SLQ-32(V)3 ESM/ECM* **16** Chaff launchers

GENERAL SPECIFICATIONS

Operator: USA

Class: ARLEIGH BURKE (Flight IIA)

Active: 0
Building: 7
Proposed: 3

Displacement:
full load: 9,217 t

Dimensions
Length:
overall: 155.3 m (509.5 ft)
waterline: 143.6 m (471.1 ft)
Beam: 20.4 m (66.9 ft)

Draught:
hull: 6.3 m (20.7 ft)
sonar: 9.9 m (32.4 ft)

Speed: 32 kts
Range: 4,400 n miles at 20 kts

Complement: 380 (32 officers)

SHIPS

OSCAR AUSTIN (DDG 79)
Builder Bath Iron Works, Bath, Maine, USA
Laid down Aug 1997
Launched Sep 1998
Commissioned Feb 2000

(DDG 80)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down Mar 1997
Launched Dec 1997
Commissioned Apr 2000

SIR WINSTON CHURCHILL (DDG 81)
Builder Bath Iron Works, Bath, Maine, USA
Laid down Mar 1998
Launched Mar 1999
Commissioned Aug 2000

(DDG 82)
Builder Ingalls Shipbuilding, Pascagoula, Mississippi, USA
Laid down Aug 1998
Launched Sep 1999
Commissioned Nov 2000

WEAPONS SYSTEMS

SURFACE-TO-SURFACE MISSILES (SSM)

BGM-109 Tomahawk

All ships are fitted with Tomahawk and any version of Tomahawk can be carried, two of which are for land-attack missions, one with a conventional HE warhead (BGM-109C Tomahawk Land Attack Missile — Conventional (TLAM-C)) and the other with submunitions (BGM-109D Tomahawk Land Attack Missile — D (TLAM-D)). The third type is the BGM-109B Tomahawk Anti-Ship Missile (TASM), which also has a conventional HE warhead. A fourth version, BGM-109A Tomahawk Land Attack Missile-Nuclear (TLAM-N), has been removed from ships at sea as a result of START I, but is retained in reserve ashore and the ships could quickly be recertified for TLAM-N in an emergency.

The major sub-type now in service is the Block II, although the Block III has been in production since 1993 and Block II missiles are being progressively brought up to the new standard. The missile is launched using a rocket booster until the turbofan engine takes over and the booster is jettisoned.

BGM-109A uses inertial navigation with terrain contour matching (Tercom), while BGM-109B uses inertial plus active radar terminal guidance, and BGM-109C/D inertial and Tercom mid-course guidance with Digital Scene Matching Area Correlation (DSMAC) for terminal guidance. Tercom stores digital terrain profile map information in the missile before launch, which is compared with radar altimeter measurements of ground elevations below the missile during a set number of sections en route to the target. The Block III upgrade programme includes a Global Positioning System (GPS) receiver to supplement or replace the Tercom system. In the terminal phase, DSMAC compares a stored digital representation of the target area with the scene viewed below the missile by a TV camera. This latter system is claimed to be extremely accurate for attacking land targets, with a circular error probable (cep) of 10 m being reported. Both the BGM-109C and D versions have a programmable terminal dive attack mode option.

The BGM-109A is fitted with a W80 135 kg (298 lb) nuclear warhead, while the BGM-109B/C have 454 kg (1,000 lb) unitary HE warheads taken from old Bullpup B missiles. The BGM-109D has 166 combined effects BLU-97B bomblets, each weighing 1.5 kg (3.3 lb) which can be dispensed in groups against up to four separate targets.

Block III missiles have a more powerful and more fuel-efficient turbofan engine, which, coupled with increased fuel capacity, results in a range increase of at least 30 per cent. The BGM-109C Block 3 missiles have a smaller WDU-36B 320 kg (700 lb) warhead carrying a unitary HE charge with a selectable fuze delay to increase warhead penetration before detonation.

Specifications

Designation	BGM-109B	BGM-109C	BGM-109C	BGM-109D
Mission	Tomahawk anti-ship missile (TASM)	Tomahawk land-attack missile — conventional (TLAM-C)	Tomahawk land-attack missile — conventional (TLAM-C)	Tomahawk land-attack missile — D (TLAM-D)
Airframe standard	Block II	Block II	Block III	Block II
Length	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)	6.25 m (20.50 ft)
Diameter	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)	0.52 m (1.71 ft)
Wing span	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)	2.65 m (8.70 ft)
Launch weight	1,452 kg (3,201 lb)	1,452 kg (3,201 lb)	n/k	1,452 kg (3,201 lb)
Warheads	454 kg HE (1,000 lb)	454 kg HE (1,000 lb)	320 kg HE (705 lb)	166 bomblets
Range	240 n miles (450 km)	490-700 n miles (900-1,300 km)	1,000 n miles (1,857 km)	490 n miles (900 km)
Accuracy — circular error probable (cep)	n/a	10 m (33 ft)	10 m (33 ft)	10 m (33 ft)
Speed	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)	Mach 0.7 (550 mph)
In-service date	1983	1983	1993	1989
Engine	Williams International F107-WR400 turbofan (272 kg thrust)	Williams International F107-WR402 turbofan (272 kg thrust)	Williams International F107-WR400 turbofan (335 kg thrust)	Williams International (272 kg thrust)
Number currently on order	593	1,486	n/k	1,157

Notes
BGM-109A (TLAM-N) is not listed as it is not deployed in operational ships, but it should be noted that it remains in reserve ashore

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA (prime).
McDonnell Douglas Missile Systems, St Louis, Missouri, USA (second source).

SURFACE-TO-AIR MISSILES (SAM)

RIM-156A Standard SM-2ER Block IV missile
SM-2ER Block IV is a dedicated vertical-launch extended-range version for Aegis-equipped ships, which will be deployed in Flight IIA ships in place of the SM-2MR in Block I and II ships. SM-2ER Block IV provides hemispheric defence and is more manoeuvrable, has greater range and can engage reduced-signature, more manoeuvrable targets at higher altitudes, all in a severe electronic warfare environment. SM-2ER Block IV differs externally from its predecessors in having dorsal fins with thin extensions, modified tail fins, and the Mk 72 finless booster (1.82 m (5.97 ft) long and 53.4 cm (21.0 in) in diameter) with Thrust Vector Control (TVC). Internally, the missile has a new low noise microwave receiver, solid-state local oscillator, and dual Motorola 68020 digital signal processors. There are also improvements to the warhead and fuzing, a new digital autopilot and a new actuation system and clamps. The Thiokol Mk 104 dual thrust rocket motor is more powerful and provides substantial improvements in speed, manoeuvrability and range.

When the target is detected the WDS evaluates the data, designates the target to the missile fire-control system, and then initiated the launch sequence. The fire control system then tracks and illuminates it, with each tracker/illuminator radar usually controlling one missile, although, using multiplexing, radars can support several missiles simultaneously. Fire-control radars can be changed and illumination frequencies altered during the missile's flight without any loss of efficiency.

The missile's course is controlled from the ship by means of an RF link until the target comes within the missile seeker's field of view, enabling the ship's search radar to provide missile launch data and to shape the missile flight path into a more energy-efficient trajectory so that the effective range of the system is doubled. During the mid-course phase, target data is passed to the missile via the RF link to update navigation data in the inertial reference unit, while the missile uses the AN/SYR-1 downlink to provide the ship with location data. In the terminal phase the onboard seeker antenna searches for energy from the illuminator radar being reflected by the target and upon acquisition homes in on it, this final phase usually involving a dive attack. This means that tracker/illuminator radars need only be used for the terminal phase, reducing the ship's exposure time.

Specifications
(SM-2ER Block IV)
Length: 6.55 m (21.5 ft)
Diameter: 34.3 cm (13.5 in)
Wing span: 1.57 m (5.1 ft)
Weight: 1,451.5 kg (3,200 lb)
Speed: Mach 2.5
Range: 81 n miles (150 km)
Altitude: 29,000 m (95,120 ft)

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA.
Raytheon Missile Systems Division.

Enhanced Sea Sparrow Missile System (ESSMS)/RIM-7RTC point defence system
Flight IIA Arleigh Burke ships will have the Enhanced Sea Sparrow Missile System (ESSMS), a developed version of the Mk 57 NATO Sea Sparrow Missile System (NSSMS), with the RIM-7RTC missile. RIM-7P, which succeeded the RIM-7M missile on the production lines in 1991, has a Missile-Borne Computer (MBC), which controls overall missile performance and links the major missile subsystems. The missile also has an improved low altitude guidance mode and enhanced sub-clutter performance against very low altitude targets. Other features include a 38.6 kg (85.1 lb) warhead with new fuze for low altitude use, a command uplink, sample data homing and multiple target designation. The RIM-7R is similar, but in addition has a dual-mode semi-active radar and infra-red seeker.

ESSM (RIM-7RTC) will have many of the features of RIM-7P and RIM-7R, including the same guidance system, but with a new autopilot and a larger rocket motor. It will be wingless and with tail control as well as integral thrust vector control both for vertical launch and to double the manoeuvrability. The system is fully compatible with the GMVLS Mk 41, but since each cell was dimensioned to house a Tomahawk missile a special module has been developed which accommodates four Sea Sparrows in a single vertical launch cell. These are known as 'quad packs'.

Targets are detected by the ship's radar and designated through the combat information centre and the tracker system then traverses onto the relevant bearing and elevation, while radar data from the director is processed in the signal data processor to provide range and angle tracking data. The data is then passed to the firing officer's console which passes pre-launch data and the firing command to the missile which is then launched. The missile lifts to a height of approximately 4 m and then begins to pitch over in the correct azimuth to the intercept point, controlled by the jet vector control, which is then jettisoned (approximately 2 seconds after lift-off). The missile follows a proportional guidance path directly to the intercept point.

Specifications
(RIM-7P/R)
Length: 3.66 m (12.00 ft)
Diameter: 20.3 cm (8.0 in)
Wing span: 1.02 m (3.34)
Weight: 231.5 kg (510.3 lb)
Speed: Mach 1
Range: 8 n miles (14.5 km)
Guidance: Semi-active radar

Manufacturers/Contractors
Raytheon Company, Equipment Division (prime — system).
Raytheon Company, Missile Systems Division (prime — missile).
Hughes Missile Systems (second missile source).

VERTICALLY LAUNCHED MISSILES

GMVLS Mk 41 Mod 0
The Arleigh Burke Flight IIA ships are fitted with two Mk 41 Mod 0 Guided Missile Vertical Launch Systems (GMVLS), one inset in the foredeck, the other in the hangar roof. The at-sea reloading system is not installed, which makes three more tubes in each magazine available, giving a total capacity of 32 cells forward and 64 aft. These are used for a mix of Tomahawk, Standard and ASROC missiles. When it enters service, the Evolved Sea Sparrow Missile (ESSM) will also be deployed, with each GMVLS tube accommodating four of the new missiles.

TORPEDOES

UUM-139 Vertical Launch ASROC (VLA) anti-submarine missiles
VLA is a three-stage ASW weapon launched from the Mk 41 GMVLS and controlled by the Mk 116 Mod 6

fire-control system. The current version of VLA carries the Mk 46 Mod 5 torpedo, but this will be changed, in due course, to the Mk 50 Barracuda. The torpedo is mated to the Mk 11 Mod 0 airframe assembly which houses the remainder of the missile. The assembly forms the first stage flight vehicle and consists of an upper and lower airframe, which are tapered to reduce drag, and have two trapezoidal fins each, to provide aerodynamic stability. The airframe assembly houses a two-stage, ribbon-type parachute which provides aerodynamic stability to the torpedo when it separates from the airframe and also slows it so that it will not disintegrate upon entering the water. The nose of the torpedo is covered by an ogive-shaped nose cap to protect it as it penetrates the cover of the canister and later as it enters the water. The missile is powered by a rocket motor with a thrust vector control, which consists of four jet vanes in the nozzle extension and leads to turnover during the boost phase of the flight.

When the target has been located the Mk 116 ASW fire control system provides launch orders and automatically selects and initiates the selected missile, while target location details are entered through the Mk 41 GMVLS launch control unit. The missile is then launched and the booster propels it out of the silo, whereupon the thrust vector control turns it towards the target. Thrust cut-off takes place at a time appropriate to the commanded range and the booster separates and falls away, leaving the missile to follow a ballistic path. As the missile descends, the airframe assembly is discarded, the ribbon parachute is deployed, and the nose-cap's steel tip is carried away. As the torpedo enters the sea, water pressure in the cavity of the nose cap causes the cap to disintegrate and the impact causes the parachute release mechanism to operate, allowing the torpedo to begin the search phase.

Artist's impression of Arleigh Burke Flight IIA. Note the twin hangars, designed to accommodate two SH-60B LAMPS-III helicopters. The flight deck is larger than in the earlier Flight I and II as a result of angling at the transom (as was done in the later 'Oliver Hazard Perry' class frigates) but this has resulted in the deletion of the SQR-19 TACTAS towed array. This 1994 artist's impression includes a Mk 15 CIWS at the forward end of the flight deck, which was omitted from earlier pictures (US Navy)

Specifications
VLA
Length: 4.89 m (16.04 ft)
Diameter: 35.81 cm (15.1 in)
Span: 69.6 cm (27.4 in)
Weight: 639.12 kg (1,409 lb)
Range: 0.86-5.39 n miles (1.6-10 km)
Speed: Mach 0.9
Limiting sea state: Sea State 6

Manufacturers/Contractors
Honeywell Inc, Training and Control Systems Operations (ASROC).
Loral Systems Group (VLA prime).
Martin Marietta (VLA second source).

Specifications — torpedoes

	Mk 46 Mod 5	Mk 50
Diameter	324 mm (12.75 in)	324 mm (12.75 in)
Length	2.95 m (9.68 ft)	2.89 m (9.48 ft)
Weight	230 kg (507 lb)	363 kg (800 lb)
Speed	40 kts	55-60 kts
Range	6 n miles (11.2 km)	10.75 n miles (20 km)
Homing	active/passive acoustic homing	
Warhead	Mk 103 Mod 1; 44 kg; PBXN-103	45 kg shaped charge HE
Motor	5-cylinder liquid mono-propellant (Otto) motor	closed-cycle

Manufacturers/Contractors
Loral Defense Systems, Akron, Ohio, USA (Mk 46).
Alliant TechSystems Inc, Marine Systems (Mk 50).
Westinghouse Electronic Corporation, Naval Systems Division.

324 mm Mk 32 triple torpedo launchers
Two triple Mk 32 torpedo launchers are mounted, one on either beam, on the roof of the hangar, abreast the after VLS launchers.

The ships will carry either Mk 46 or Mk 50 torpedoes; see VLA entry (above) for details.

GUN

Mk 45 Mod 1 single 127 mm (5 in) L/54 gun mounting
One United Defense single 127 mm (5 in) Mk 45 Mod 1 gun is mounted forward, firing semi-fixed ammunition with point detonating, proximity (variable time or infrared), mechanical time and electronically set fuzes. The theoretical rate of fire is 20 rpm and a gun crew of six is required, all below decks, of which four are ammunition handlers. The Mod 1 incorporates a number of improvements over the Mod 0, including the ability to change the type of ammunition under remote control and electronic fuze setting. The Semi-Active Laser-Guided Projectile (SALGP) Prototype Mod 3 will start trials in 1998. This shell has a range of 20 n miles (37 km).

Specifications
Calibre: 127 mm (5 in)
Length of barrel: 54 calibres
Muzzle velocity: 807.72 m/s (new barrel), 762 m/s (mid-life) (2,649.3-2,499.3 ft/s)
Crew: 6 (1 mount captain, 1 panel operator, 4 ammunition handlers)
Traverse: 340° at 30°/s
Elevation: −15 to +65° at 20°/s
Range:
anti-ship: 12.39 n miles (23 km)
anti-air: 15,000 m (49,000 ft)
Rate of fire: 16-20 rds/min
Ammunition weight: 31.75 kg (projectile)

Manufacturer/Contractor
United Defense, Armament Systems Division, Minneapolis, Minnesota, USA.

Hughes Mk 15 CIWS Phalanx
DDG 79 to DDG 84 will be are fitted with two Hughes Mk 15 Phalanx Close In Weapons Systems (CIWS) to provide the innermost layer of defence against anti-ship missiles. These are in the same positions as in Flights I and II; one mount being on a small platform immediately before the bridge screen, the other atop the after deckhouse. Each mount consists of a 20 mm M61A1 Vulcan, six-barrel, Gatling-principle gun with a cylindrical magazine and feeding mechanism suspended beneath. Firing usually begins at 1 n mile (1.85 km) with a maximum probable kill at 460 m (1,500 ft). System reaction time is reported to be 3 seconds. These mounts are being fitted with IR detectors to enable them to track small boats.

Specifications
Gun
Calibre: 20 mm
Length of barrel: 76 calibres
Muzzle velocity: 1,030 m/s (3,380 ft/s)
Rate of fire: 3,000 rds/min (Block 0, Block 1 Baseline 0), 4,500 rds/min (Block 1 Baseline 1)
Range: 0.75 n miles (1.47 km) (effective, horizontal)
Traverse: 310° at 126°/s
Elevation: −25 to +85° at 92°/s

AN/UPS-2 radar
Frequency: 12-18 GHz (J-band)
System: Pulse Doppler

Manufacturers/Contractors
Hughes Missile Systems, Tucson, Arizona, USA (system).

ELECTRONIC WARFARE SYSTEMS

ELECTRONIC SUPPORT MEASURES/ ELECTRONIC COUNTERMEASURES (ESM/ECM)

AN/SLQ-32(V)3 jammer suite

The SLQ-32(V)3 suite is designed to give radar warning and jamming/deception. The ESM capability is the same as that of the AN/SLQ-32(V)2 suite, but extra equipment racks are added in the EW room and computer memory is increased from 64 to 80 k. The hydraulically roll-stabilised, outboard antenna assemblies are also enlarged to accommodate Band 3 transmitter antennas and electronics; two are located in the lower portion of each assembly. The AN/SLQ-32(V)3 AECM (Active Electronic CounterMeasures) mode can be invoked either semi-automatically with the operator initiating jamming against a given emitter or automatically. In the latter case, the computer directs the operation, initiating countermeasure action as soon as a threat is identified by generating an appropriate response in the required direction. The computer also schedules transmissions, enabling multiple targets to be countered simultaneously.

Manufacturer/Contractor

Raytheon Company, Electromagnetic Systems Division, Goleta, California, USA.

DECOYS

Loral Hycor SRBOC Mk 36 6-barrelled Chaff Launcher

There are two Mk 36 SRBOC (Super Rapid Bloom Offboard Countermeasures) units, with two pairs mounted on small platforms just before the forward stack.

Specifications

Launcher
Dimensions: 160 × 43 × 86 cm
Weight: 173 kg (381.4 lb)
Range: 4 km (2.2 n miles)

Rounds
Mk 182: 1,209 × 130 mm; 22.7 kg
Super Chaffstar: 1,209 × 130 mm; 20.9 kg
Super Gemini: 451 × 130 mm; 5.5 kg
Super Hiram III: 1,220 × 130 mm; 13.6 kg
Super Hiram IV: 467 × 130 mm; 3.8 kg
Super Loroc: 734 × 130 mm; 13.2 kg

Manufacturers/Contractors

Loral Hycor Inc, Woburn, Maryland, USA.
Tracor Aerospace Inc (SCIP), Austin, Texas, USA.

COMMAND AND CONTROL SYSTEMS

COMMUNICATIONS AND DATALINKS

Communications systems will include:
JTIDS
Tactical Data Information Exchange System-B (TADIX-B)
Tactical Data Information Link-J (TADIL-J).

WEAPONS CONTROL

Aegis Mk 7 command and weapon system

The Aegis system is technically similar to that in Flights I and II ships, but with the two after planar arrays raised by some 2 m (6.5 ft), bringing them to the same level as the bridge, in order to clear the hangar roof. Aegis has a federated architecture and consists of four subsystems supported by the Aegis Operational Readiness Test System (ORTS) with a single computer. The subsystems, each backed by four AN/UYK-43B 32-bit computers, are:

(a) AN/SPY-1D multifunction radar
(b) The Command and Decision System (CDS) Mk 2
(c) The Aegis Display System (ADS) Mk 2
(d) The Weapon Control System (WCS) Mk 8

There are four operating modes; automatic, automatic special, semi-automatic and casualty. The automatic special mode ensures that targets which meet predetermined threat criteria will be automatically engaged unless the order is overridden manually. The other modes are self-explanatory, but in all of them the firing is initiated manually.

AN/SPY-1D(V)

The prime sensor is the Lockheed Martin AN/SPY-1D (V), an E/F-band (2-4 GHz) multifunction radar which conducts horizon and hemispherical searches, multiple target tracking and multiple target designation. The radar also acts as a two-way link with missiles for mid-course guidance when requested to do so through the weapon control system. The four antennas are installed at the four corners of the bridge superstructure at an angle of approximately 45° and maintain accurate co-ordination even if the ship is moving ±30° in roll and ±15° in pitch.

A signal processor controls the high power, ultra-precision, high temperature resistant garnet phase shifters which integrate microwave and electronic hardware. There are 4,100 phase shifters in each antenna steering the beam to cover the sectors and designated targets, although some phase shifters are also used to eliminate sidelobes.

The Aegis system installed in Flight IIA ships will be the first to include a Track Initiation Processor.

AN/SPS-67(V)3

SPY-1D radar is complemented by dedicated radars including the Norden AN/SPS-67(V)3 G-band (4-6 GHz) surface search radar and the SPS-64(V)9. The SPS-67 surface search radar retains the open lattice construction, horn feed antenna of the AN/SPS-10. It operates in narrow (0.1 μs), medium (0.25 μs) and long (1 μs) pulse modes for detecting targets in the open sea (2400, 1200, 750 pps respectively). Performance is further improved by a digital video clutter suppressor and an interference suppressor. The version used in the 'Arleigh Burke' class, SPS-67(V)3, provides DMTI, automatic target detection and track-while-scan capabilities to improve naval gunfire support in association with the Mk 34 fire-control system.

AN/SPS-64(V)9

AN/SPS-64(V)9 is an I-band Raytheon navigation radar. It is widely used within the US armed forces, with (V)9 being a version specially designed for the US Navy.

CDS Mk 2

The Command and Decision System Mk 2 provides overall operational direction and co-ordination. It receives data from onboard sensors and also from offboard sensors through Link 11, Link 14 and Link 16-JTIDS. The system is used to help assess threats and will assign engagement instructions to the WCS. In addition to inputs from radar and sonar sensors it also receives inputs from the AN/SLQ-32(V) electronic warfare suite. DDG 51 to DDG 71 will have AN/SLQ-32(V)2 system which is purely an ESM system designed to detect, identify and track potential targets, but DDG 72 onwards will have the AN/SLQ-32(V)3 system which has an additional ECM capability enabling it to jam hostile radars but can perform both ESM and ECM duties simultaneously. Those destroyers with AN/SLQ-32(V)2 will receive an additional ECM capability in the Sidekick programme. CDS Mk 2 receives further direct inputs from the SQQ-89 sensors both onboard through the Mk 116 fire control system and offboard from the Light Airborne MultiPurpose System (LAMPS) ASW helicopter datalink.

GFCS Mk 34 Mod 0

The integral Gun Fire Control System Mk 34 Mod 0 interfaces directly with the CDS through its AN/OJ-451(V)9 console. GFCS Mk 34 has a Unisys Mk 20 signal data converter/gun mount processor which accepts data from the AN/SPY-1D and AN/SPS-67 radars as well as the Mk 46 electro-optic sight. Gun and solution status statements are then made to the Mk 160 Mod 4 gun computing system which provides target data to the Mk 20 which in turn provides the gun with orders and fuze instructions.

ADS Mk 2

The Aegis Display System Mk 2 consists of two computer-driven large screen (1.06 × 1.06 m) (3.4 × 3.4 ft) displays with processed data and automated status boards (ASTAB) which in later ships will be replaced by similar Central Alphanumerics Generators (CAG). It allows the ship's commander, the tactical action officer and the task group commander (if embarked) to assess the operational situation and to issue orders both to onboard and offboard weapon systems and units. ADS control consists of two Mk 123/124 Advanced Large Screen Display Controllers and an AN/OJ-471 console for each pair of screens. Within the CIC are some 18 consoles including an AN/SPG-25 for navigation radar. Supporting the Aegis system are consoles for sensor control including those for the radar system supervisor, radar track manager and ESM manager, for weapon control with consoles for the anti-air warfare coordinator, missile engagement controller, two air intercept controllers and fire control system supervisor. There is a four-console anti-submarine warfare team and one for surface warfare. The remaining consoles are for the AN/SWG-3A fire-control system used with Tomahawk surface-to-surface missiles, the AN/SWG-1A used with the Harpoon anti-ship missile, the Mk 86 Mod 9 gun fire-control system and the AN/SLQ-32 electronic warfare suite.

WCS Mk 8

The Mk 8 Aegis WCS (Weapon Control System) is for the engagement of targets in the air, on the surface and underwater, although the priority is given to engaging air targets. The system interfaces with sensors of various onboard systems and offboard systems with direct links to the LAMPS ASW helicopter and through Link 4 A to aircraft. The system receives engagement instructions through the CDS and selects the appropriate weapons system and weapon. It schedules targets, issues firing orders and controls surface-to-air missiles launched by the Mk 99 fire-control system until they are close to the interception point.

The WCS interfaces with several fire-control systems and the Phalanx CIWS. The fire-control systems are the Mk 34 gun fire control system to support the 5 in (127 mm) gun, the Mk 116 Mod 7 anti-submarine system, the AN/SWG-1A (Harpoon) and AN/SWG-3A (Tomahawk), the LAMPS Mk III ASW helicopter, the missile launching system (Mk 26 or Mk 41) and the Aegis integral surface-to-air missile fire-control system, the Mk 99 Mod 3.

MFCS Mk 99 Mod 3

The Mk 99 generates director and launcher commands for the three slaved SPG-62 illuminator radars which are also used to provide target illumination for missiles from other ships. The Mk 99 selects the missile engagement mode then acquires and tracks the target using uplink mid-course command guidance through the SPY-1, which generates continuous targeting data, to guide the missile close to the target which is then illuminated by the SPG-62s for the terminal phase.

SWG-3 Tomahawk WCS

SWG-3 is the weapon control system for the Tomahawk missile.

AN/SWG-1A Harpoon Launch Control System (LCS)

The SWG-1A Harpoon Launch Control System activates the missile, selects the flight pattern and sets seeker search modes (with small, medium or large acquisition windows), as well as providing target range and bearing data. Alternatively, the missile can simply be launched along the bearing of the target, with the seeker activated early to scan a 90° sector; if, after a set time, no target has been acquired the missile commences a preset search pattern. SWG-1A takes

account of other ships in the general target area and generates indirect flight plans for the missile, including waypoints to optimise angles of approach which will achieve the highest possibility of success while minimising the chances of the missile being destroyed by hostile fire. It can also be used to compute flight plans in a multiple attack so that several missiles, from either the same or different ships, arrive on target simultaneously, thus swamping the defences.

AIMS AS-3134/UPX-29

AIMS is the IFF component of the Aegis system, and, like the AN/SPY-1D, it uses electronic scanning.

Manufacturers/Contractors

Aegis
Lockheed Martin, Government Electronic Systems (prime).
Unisys (computers).
Computer Sciences Corporation (software).
Hughes Aircraft Company (display).
Raytheon (Mk 99 fire control system).
Lockheed Martin, Government Electronic Systems (SWG-1A).
Lockheed (AIMS).

SONARS

The anti-submarine warfare system comprises the Mk 116 Mod 7 ASW fire-control system, the AN/SQQ-89(V)6 combat system and the AN/SQS-53C bow-mounted sonar array, coupled with the AN/SQQ-28 SSPS which processes data received from the LAMPS I/III helicopter. All ships will also have the Kingfisher mine avoidance sonar. It should be noted that, due to the extended flight deck and other changes in the stern, there is no AN/SQR-19 (TACTAS) towed array in the Flight IIA ships.

Mk 116 Mod 7 anti-submarine fire-control system

The Mk 116 underwater fire-control system is designed to provide tactical data processing, contact management, target engagement processing and weapon fire control and consists of two elements; the Computer Processing Subsystem (CPS) and the Weapon Control and Setting Subsystem (WCSS). Data are also received from external sensors and distributed around the system by an integral switchboard or data converter.

The CPS provides displays of tactical data, computes and stores track data, calculates weapon control firing solutions for selected targets and generates weapon recommendations and launcher orders. The Mod 7 system in the 'Arleigh Burke' class is based upon two AN/UYK-43B computers, each of which has two Central Processing Units (CPU) with a memory of 2,560,000 words and an optimum processing power of 3,002,000 operations/s. The US Navy's own CMS-2 computer language is used.

The WCSS consists of the Mk 329 weapon control panel which selects the fire control mode, the sensor-weapon pairing, weapon and launcher, torpedo presetting and then launches the weapon. The external sensors all include an electromagnetic log and the Type F wind indicator. The other sensors and the data distribution unit are tabulated alongside. These elements of the WCSS are the same as in other versions of the Mk 116, except that the Mod 7 (the version used in the 'Arleigh Burke' class) has a different display system and data converter.

Manufacturer/Contractor

Loral Librascope.

AN/SQQ-89(V)6 anti-submarine combat system

The AN/SQQ-89(V)6 surface ship anti-submarine warfare combat system detects, locates, tracks and engages submarine targets, which transmits and/or receives acoustic signals using a variety of sensors. Received signals are processed to provide target classification as well as performing TMA (Target Motion Analysis) and controlling the setting of own-ship ASW weapons. In addition it provides multisensor track correlation, track management control and forwards track data to ship's Combat Direction System (CDS) or Command and Decision System (CDS). The system is an integrated combat system consisting of sonar sensors which interface with the Mk 116 fire control system to provide maximum operational effectiveness combined with minimum manpower requirements.

In the Arleigh Burke Flight IIA ships, the sensors integrated in AN/SQQ-89(V) are the AN/SQS-53C hull-mounted sonar and the AN/SQQ-28 LAMPS I/III Sonar Signal Processing System (SSPS). These are supported by the AN/UYQ-25 Data Processing System (DPS) and its associated Sonar In-situ Mode Assessment System (SIMAS) computer program. The fire-control subsystem is the Mk 116 Mod 7.

AN/SQS-53C

The only on-board ASW sensor is the bow-mounted, low-frequency AN/SQS-53C active/passive sonar, which has a cylindrical array 1.6 m (5.2 ft) high and (15.7 ft) 4.8 m in diameter with 576 transducers. The sonar is reported to have an active transmitting frequency of about 3 kHz and a peak frequency of 192 kHz. AN/SQS-53C operates in three active modes; surface duct, bottom bounce and convergence zone, and ranges are reported to be approximately 10 n miles (18.5 km) in surface duct mode and up to 34.5 n miles (64 km) in convergence zone mode. Passive detection range is reportedly greater than the previous SQS-26 with the ship capable of operating at higher speeds, which helps to give the system a multiple target tracking capability.

The SQS-53C can detect, classify and locate both subsurface and surface targets using active and passive means. It consists of four major subsystems, the array, the transmitter, the receiver and the control/display. SQS-53C is electronically embedded in the SQQ-89 combat system.

AN/SQQ-28(V)9 SSPS

The AN/SQQ-28 Shipboard Sonar Processing System (SSPS) processes raw data from sonobuoys laid by the Sikorsky SH-60B Seahawk ASW helicopters and relayed to the ship via the AN/SQR-4 duplex digital link and received by the AN/ARR-75 receiver. The AN/UYQ-25A(V)2 DPS and the associated SIMAS provide a computer-based capability for sonar in-situ performance prediction and mode selection to provide the most effective AN/SQQ-89 system performance in various environmental conditions.

Kingfisher

Kingfisher is a hull-mounted, active, high-frequency mine detection sonar.

AVIATION

AVIATION FACILITIES

Specification

Flight deck: 25 × 20.4 m (82 × 67 ft)
Hangars: There are two large hangars
Helicopters: 2 SH-60B/F LAMPS III

HELICOPTERS

Sikorsky SH-60B Seahawk (LAMPS III)

Specifications

Dimensions
Main rotor diameter: 16.36 m (53.66 ft)
Tail rotor diameter: 3.35 m (11.00 ft)
Length overall (fuselage): 15.26 m (50.0 ft)
Height (to top of rotor head): 3.79 m (12.43 ft)
Weights:
empty: 6,191 kg (13,648 lb)
mission gross weight: 9,182 kg (20,244 lb)
Performance:
dash speed (typical): 126 kts (234 km/h)
vertical rate of climb at sea level: 213 m (700 ft)/min
Power plant: 2 General Electric T700-GE-401C turboshafts rated at 1,417 kW (1,900 shp)
Accommodation: 3 (pilot and airborne tactical officer/back-up pilot in cockpit, sensor operator in specially equipped station in cabin)
Communications: Collins AN/ARC-159(V)2 UHF, Collins AN/ARC-174(V)2 HF, Hazeltine AN/APX-76A(V) and Bendix/King AN/APX-100(V)1 IFF transponders, TSEC/KG-45(E-1) communications security set, TSEC/KY-75 voice security set, Telephonics OK-374/ASC communications system control group
Mission avionics: Sikorsky sonobuoy launcher, Edmac AN/ARR-75 and R-1651/ARA sonobuoy receiving sets (AN/ARR-84 receiver in Block 1 upgrade), Texas Instruments AN/ASQ-81(V)2 towed MAD, Raymond MU-670/ASQ magnetic tape memory unit, Astronautics IO-2177/ASQ altitude indicator, Fairchild AN/ASQ-164 control indicator set, Fairchild AN/ASQ-165 armament control indicator set, IBM AN/UYS-1(V)2 Proteus acoustic processor and CV-3252/A converter display, Control Data AN/AYK-14 (XN-1A) digital computer, Raytheon AN/ALQ-142 ESM, Sierra Research AN/ARQ-44 datalink and telemetry
Armament: Two Mk 46 torpedoes; 2 AGM-119B Penguin 2 Mod 7 anti-shipping missiles; 2 Honeywell 50 Advanced Lightweight Torpedoes; Hellfire missiles

PROPULSION

Specifications

System: Combined gas turbine and gas turbine (COGAG)
Main machinery: 4 General Electric LM-2500-30 gas turbines; 78.33 MW (105,000 hp) sustained
Shafts: 2
Propellers: cp

FURTHER INFORMATION

PROGRAMME

The original Arleigh Burke design has been criticised for the lack of helicopter facilities and the first attempt to provide such a ship resulted in the Flight III design. This was cancelled for financial reasons and replaced by the Flight IIA, a (supposedly) relatively minor modification of the Flight II design. DDG 79, the first Flight IIA ship, was authorised in the FY94 budget and laid down in October 1996 at Bath Iron Works, Bath, Maine, USA. Funding for a further three was provided in FY95 and a further two were requested in FY96. DDGs 83 and 85 will be built by Bath Iron Works and DDG 84 by Ingalls.

DESIGN

The major change incorporated in Flight IIA is the provision of full aviation facilities, which is achieved by a major reworking of the after superstructure to enable a double hangar to be installed. There are, in fact, two separate hangars, with the after vertical launcher between them. In addition, the transom has been extended and is now angled sharply outwards, thus enabling the flight deck to be enlarged and a RAST system fitted. The major penalty of this arrangement is that the AN/SQR-19 TACTAS towed array cannot be installed.

The At Sea Missile Handling System has also been deleted, freeing three cells in both forward and aft missile launch groups and increasing missile capacity from 29 forward and 61 aft, to 32 and 64, respectively. The Vertical Launchers will also be able to launch the agile Evolved Sea Sparrow Missile (ESSM) which replaces Phalanx, although Phalanx will still be fitted in DDG 79 to DDG 84. A decision is awaited on Harpoon and, at least initially, the ships may be fitted for, but not with it. Other changes include the addition of the Kingfisher minehunting sonar, a reconfiguration of the after SPY-1D arrays which are raised to be level with the bridge, and the inclusion of a track initiation processor in the Aegis radar system.

Much internal cabling is replaced by fibre optic connectors, which reduce overall weight, increase capacity and improve reliability.

A Kollmorgen optronic bridge periscope is fitted.

NAMES

Only two names have so far been decided, the second, *Sir Winston Churchill* (DDG 81), being unusual in United States' practice as it is the name of a non-US citizen. The only other current US warship bearing a foreigner's name is *Comte De Grasse* (DD 974).

Contractors List

Where a discrepancy exists between data on the text pages and in this listing, the listing should be accepted as the most up to date and correct version as it is composed after the text has been completed, and there are often last-minute changes which cannot be included in the text.

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Index of Pennant Numbers

012 *Rais Hadj Mubarek* (Alg) 394
013 *El Hadj Slimane* (Alg) 394
061 *Chang Bogo* (RoK) 344
062 *Yi Chon* (RoK) 344
063 *Choi Muson* (RoK) 344
065 *Pakui* (RoK) 344
066 *Lee Jongmu* (RoK) 344
067 (RoK) 344
11 *Prat* (Chi) 644
12 *Cochrane* (Chi) 644
14 *Latorre* (Chi) 644
15 *Blanco Encalada* (Chi) 644
19 *Almirante Williams* (Chi) 515
20 *Thomson* (Chi) 330
21 *Simpson* (Chi) 330
22 *O'Brien* (Chi) 437
23 *Hyatt* (Chi) 437
38 *Perth* (Aust) 716
39 *Hobart* (Aust) 716
41 *Brisbane* (Aust) 716
60 *Onslow* (Aust) 431
61 *Orion* (Aust) 431
61 *Babr* (Iran) 673
62 *Otama* (Aust) 431
62 *Palang* (Iran) 673
72 *Ojibwa* (Can) 435
73 *Onondaga* (Can) 435
74 *Okanagan* (Can) 435
83 *Nadezhda* (Bul) 278
84 *Aguirre* (Per) 467
84 *Slava* (Bul) 278
105 *Jinan* (PRC) 521
106 *Xian* (PRC) 521
107 *Yinchuan* (PRC) 521
108 *Xining* (PRC) 521
109 *Kaifeng* (PRC) 521
110 *Dalian* (PRC) 521
111 *Marasesti* (Rom) 610
112 *Haribing* (PRC) 518
113 *Qingdao* (PRC) 518
131 *Nanjing* (PRC) 521
132 *Hefei* (PRC) 521
133 *Chongqing* (PRC) 521
134 *Zunyi* (PRC) 521
161 *Changsha* (PRC) 521
162 *Nanning* (PRC) 521
163 *Nanchang* (PRC) 521
164 *Guilin* (PRC) 521
165 *Zhanjiang* (PRC) 521
166 *Zhuhai* (PRC) 521
271 *Warszawa* (Pol) 621
280 *Iroquois* (Can) 509
281 *Huron* (Can) 509
282 *Athabaskan* (Can) 509
283 *Algonquin* (Can) 509
291 *Orzel* (Pol) 399
401 *Cakra* (Indo) 342
402 *Nanggala* (Indo) 342
406 *Xia* (PRC) 157
521 *Delfinul* (Rom) 401
791 *Hai Shih* (RoC) 445
792 *Hai Bao* (RoC) 445
793 *Hai Lung* (RoC) 380
794 *Hai Hu* (RoC) 380
821 *Heroj* (Yug) 453
823 *Uskok* (Yug) 453
831 *Sava* (Yug) 455
832 *Drava* (Yug) 455
849 (Egy) 279
852 (Egy) 279
855 (Egy) 279
858 (Egy) 279
901 *Tareq* (Iran) 398
902 *Noor* (Iran) 398
903 (Iran) 398
907 *Fu Yang* (RoC) 702
908 *Kwei Yang* (RoC) 669
911 *Chakri Naruebet* (Tld) 34
911 *Dang Yang* (RoC) 707
912 *Chen Yang* (RoC) 711
915 *Han Yang* (RoC) 707
917 *Nan Yang* (RoC) 702
918 *An Yang* (RoC) 669
919 *Kun Yang* (RoC) 669
920 *Lai Yang* (RoC) 707
921 *Liao Yang* (RoC) 711
921 *El Fateh* (Egy) 638
923 *Shen Yang* (RoC) 711
924 *Kai Yang* (RoC) 707
925 *Te Yang* (RoC) 711
926 *Shuei Yang* (RoC) 702
927 *Yun Yang* (RoC) 711
928 *Chen Yang* (RoC) 711
929 *Shao Yang* (RoC) 711
A 11 *Minas Gerais* (Brz) 43
C 550 *Vittorio Veneto* (Ita) 459
C 551 *Giuseppe Garibaldi* (Ita) 16
CG 47 *Ticonderoga* (USA) 495
CG 48 *Yorktown* (USA) 495
CG 49 *Vincennes* (USA) 495
CG 50 *Valley Forge* (USA) 495
CG 51 *Thomas S Gates* (USA) 495
CG 52 *Bunker Hill* (USA) 495
CG 53 *Mobile Bay* (USA) 495
CG 54 *Antietam* (USA) 495
CG 55 *Leyte Gulf* (USA) 495
CG 56 *San Jacinto* (USA) 495
CG 57 *Lake Champlain* (USA) 495
CG 58 *Philippine Sea* (USA) 495
CG 59 *Princeton* (USA) 495
CG 60 *Normandy* (USA) 495
CG 61 *Monterey* (USA) 495
CG 62 *Chancellorsville* (USA) 495
CG 63 *Cowpens* (USA) 495
CG 64 *Gettysburg* (USA) 495
CG 65 *Chosin* (USA) 495
CG 66 *Hue City* (USA) 495
CG 67 *Shiloh* (USA) 496
CG 68 *Anzio* (USA) 496
CG 69 *Vicksburg* (USA) 496
CG 70 *Lake Erie* (USA) 496
CG 71 *Cape St George* (USA) 496
CG 72 *Vella Gulf* (USA) 496
CG 73 *Port Royal* (USA) 496
CGN 36 *California* (USA) 485
CGN 37 *South Carolina* (USA) 485
CGN 40 *Mississippi* (USA) 489
CGN 41 *Arkansas* (USA) 489
CLM 81 *Almirante Grau* (Per) 464
CV 59 *Forrestal* (USA) 61
CV 60 *Saratoga* (USA) 61
CV 61 *Ranger* (USA) 61
CV 62 *Independence* (USA) 61
CV 63 *Kitty Hawk* (USA) 66
CV 64 *Constellation* (USA) 66
CV 66 *America* (USA) 66
CV 67 *John F Kennedy* (USA) 66
CVN 65 *Enterprise* (USA) 70
CVN 68 *Nimitz* (USA) 74
CVN 69 *Dwight D Eisenhower* (USA) 74
CVN 70 *Carl Vinson* (USA) 74
CVN 71 *Theodore Roosevelt* (USA) 74
CVN 72 *Abraham Lincoln* (USA) 74
CVN 73 *George Washington* (USA) 74
CVN 74 *John C Stennis* (USA) 74
CVN 75 *Harry S Truman* (USA) 75
CVN 76 *Ronald Reagan* (USA) 75
D 1 *Hercules* (Arg) 662
D 2 *Santisima Trinidad* (Arg) 662
D 51 *Rajput* (Ind) 617
D 52 *Rana* (Ind) 617
D 53 *Ranjit* (Ind) 617
D 54 *Ranvir* (Ind) 617
D 55 *Ranvijay* (Ind) 617
D 86 *Birmingham* (UK) 650
D 87 *Newcastle* (UK) 650
D 88 *Glasgow* (UK) 650
D 89 *Exeter* (UK) 650
D 90 *Southampton* (UK) 650
D 91 *Nottingham* (UK) 650
D 92 *Liverpool* (UK) 650
D 95 *Manchester* (UK) 656
D 96 *Gloucester* (UK) 656
D 97 *Edinburgh* (UK) 656
D 98 *York* (UK) 656
D 108 *Cardiff* (UK) 650
D 160 *Alamgir* (Pak) 687
D 166 *Taimur* (Pak) 687
D 167 *Tughril* (Pak) 687
D 185 *Lütjens* (Ger) 721
D 186 *Mölders* (Ger) 721
D 187 *Rommel* (Ger) 721
D 218 *Kimon* (Gre) 727
D 219 *Nearchos* (Gre) 727
D 220 *Formion* (Gre) 727
D 221 *Themistocles* (Gre) 727
D 345 *Tucetepe* (Tur) 691
D 346 *Alcitepe* (Tur) 695
D 347 *Anittepe* (Tur) 695
D 349 *Kilic Ali Pasa* (Tur) 691
D 350 *Piyale Pasa* (Tur) 691
D 550 *Ardito* (Ita) 554
D 551 *Audace* (Ita) 554
D 560 *Luigi Durand De La Penne* (Ita) 560
D 561 *Francesco Mimbelli* (Ita) 560
D 602 *Suffren* (Fra) 532
D 603 *Duquesne* (Fra) 532
D 610 *Tourville* (Fra) 527
D 611 *Duguay-Trouin* (Fra) 527
D 612 *de Grasse* (Fra) 527
D 614 *Cassard* (Fra) 545
D 615 *Jean Bart* (Fra) 545
D 640 *Georges Leygues* (Fra) 538
D 641 *Dupleix* (Fra) 538
D 642 *Montcalm* (Fra) 538
D 643 *Jean de Vienne* (Fra) 538
D 644 *Primauguet* (Fra) 538
D 645 *La Motte-Picquet* (Fra) 539
D 646 *Latouche-Treville* (Fra) 539
DD 101 *Murasame* (Jpn) 594
DD 102 *Harusame* (Jpn) 594
DD 103 (Jpn) 594
DD 104 (Jpn) 594
DD 105 (Jpn) 594
DD 106 (Jpn) 594
DD 118 *Murakumo* (Jpn) 569
DD 122 *Hatsuyuki* (Jpn) 584
DD 123 *Shirayuki* (Jpn) 584
DD 124 *Mineyuki* (Jpn) 584
DD 125 *Sawayuki* (Jpn) 584
DD 126 *Hamayuki* (Jpn) 584
DD 127 *Isoyuki* (Jpn) 584
DD 128 *Haruyuki* (Jpn) 584
DD 129 *Yamayuki* (Jpn) 584
DD 130 *Matsuyuki* (Jpn) 584
DD 131 *Setoyuki* (Jpn) 584
DD 132 *Asayuki* (Jpn) 584
DD 133 *Shimayuki* (Jpn) 584
DD 141 *Haruna* (Jpn) 572
DD 142 *Hiei* (Jpn) 572
DD 143 *Shirane* (Jpn) 576
DD 144 *Kurama* (Jpn) 576
DD 151 *Asagiri* (Jpn) 589
DD 152 *Yamagiri* (Jpn) 589
DD 153 *Yuugiri* (Jpn) 589
DD 154 *Amagiri* (Jpn) 589
DD 155 *Hamagiri* (Jpn) 589
DD 156 *Setogiri* (Jpn) 589
DD 157 *Sawagiri* (Jpn) 589
DD 158 *Umigiri* (Jpn) 589
DD 164 *Takatsuki* (Jpn) 580
DD 165 *Kikuzuki* (Jpn) 580
DD 168 *Tachikaze* (Jpn) 597
DD 169 *Asakaze* (Jpn) 597
DD 170 *Sawakaze* (Jpn) 597
DD 171 *Hatakaze* (Jpn) 601
DD 172 *Shimakaze* (Jpn) 601
DD 173 *Kongo* (Jpn) 605
DD 174 *Kirishima* (Jpn) 605
DD 175 *Myoko* (Jpn) 605
DD 176 (Jpn) 605
DD 915 *Chung Buk* (RoK) 679
DD 916 *Jeon Buk* (RoK) 679
DD 919 *Taejon* (RoK) 679
DD 963 *Spruance* (USA) 731
DD 964 *Paul F Foster* (USA) 731
DD 965 *Kinkaid* (USA) 731
DD 966 *Hewitt* (USA) 731
DD 967 *Elliott* (USA) 731
DD 968 *Arthur W Radford* (USA) 731
DD 969 *Peterson* (USA) 731
DD 970 *Caron* (USA) 731
DD 971 *David R Ray* (USA) 731
DD 972 *Oldendorf* (USA) 732
DD 973 *John Young* (USA) 732
DD 974 *Comte de Grasse* (USA) 732
DD 975 *O'Brien* (USA) 732
DD 976 *Merril* (USA) 732
DD 977 *Briscoe* (USA) 732
DD 978 *Stump* (USA) 732
DD 979 *Conolly* (USA) 732
DD 980 *Moosbrugger* (USA) 732
DD 981 *John Hancock* (USA) 732
DD 982 *Nicholson* (USA) 732
DD 983 *John Rodgers* (USA) 732
DD 984 *Leftwich* (USA) 732
DD 985 *Cushing* (USA) 732
DD 986 *Harry W Hill* (USA) 732
DD 987 *O'Bannon* (USA) 732
DD 988 *Thorn* (USA) 732
DD 989 *Deyo* (USA) 732
DD 990 *Ingersoll* (USA) 732
DD 991 *Fife* (USA) 732
DD 992 *Fletcher* (USA) 732
DD 997 *Hayler* (USA) 732
DDG 51 *Arleigh Burke* (USA) 748
DDG 52 *Barry* (USA) 748
DDG 53 *John Paul Jones* (USA) 748
DDG 54 *Curtis Wilbur* (USA) 748

DDG 55 *Stout* (USA) 748
DDG 56 *John S McCain* (USA) 748
DDG 57 *Mitscher* (USA) 748
DDG 58 *Laboon* (USA) 748
DDG 59 *Russell* (USA) 748
DDG 60 *Paul Hamilton* (USA) 748
DDG 61 *Ramage* (USA) 748
DDG 62 *Fitzgerald* (USA) 748
DDG 63 *Stethem* (USA) 748
DDG 64 *Carney* (USA) 748
DDG 65 *Benfold* (USA) 748
DDG 66 *Gonzalez* (USA) 748
DDG 67 *Cole* (USA) 748
DDG 68 *The Sullivans* (USA) 749
DDG 69 *Milius* (USA) 749
DDG 70 *Hopper* (USA) 749
DDG 71 *Ross* (USA) 749
DDG 72 *Mahan* (USA) 749
DDG 73 *Decatur* (USA) 749
DDG 74 *McFaul* (USA) 749
DDG 75 *Donald Cook* (USA) 749
DDG 76 *Higgins* (USA) 749
DDG 77 *O'Kane* (USA) 749
DDG 78 *Porter* (USA) 749
DDG 79 *Oscar Austin* (USA) 758
DDG 80 (USA) 758
DDG 81 *Sir Winston Churchill* (USA) 758
DDG 82 (USA) 758
DDG 993 *Kidd* (USA) 742
DDG 994 *Callaghan* (USA) 742
DDG 995 *Scott* (USA) 742
DDG 996 *Chandler* (USA) 742
DM 74 *Ferre* (Per) 641
E 01 *Cuitlahuac* (Mex) 667
E 10 *Ilhuicamina* (Mex) 684
E 11 *Netzahualcoyotl* (Mex) 684
R 05 *Invincible* (UK) 54
R 06 *Illustrious* (UK) 54
R 07 *Ark Royal* (UK) 54
R 11 *Principe de Asturias* (Spn) 29
R 11 *Vikrant* (Ind) 47
R 22 *Viraat* (Ind) 50
R 91 *Charles de Gaulle* (Fra) 8
R 98 *Clemenceau* (Fra) 3
R 99 *Foch* (Fra) 3
S 20 *Humaita* (Brz) 433
S 20 *Kursura* (Ind) 409
S 21 *Tonelero* (Brz) 433
S 21 *Karanj* (Ind) 409
S 22 *Riachuelo* (Brz) 433
S 28 *Vanguard* (UK) 182
S 29 *Victorious* (UK) 182
S 30 *Vigilant* (UK) 182
S 30 *Tupi* (Brz) 328
S 31 *Vengeance* (UK) 182
S 31 *Sabalo* (Ven) 352
S 31 *Salta* (Arg) 325
S 31 *Tamoio* (Brz) 328
S 32 *Caribe* (Ven) 352
S 32 *San Luis* (Arg) 325
S 32 *Timbira* (Brz) 328
S 33 *Tapajos* (Brz) 328
S 34 *Tocantins* (Brz) 274
S 35 *Tamandare* (Brz) 274
S 40 *Upholder* (UK) 439
S 40 *Vela* (Ind) 409
S 41 *Unseen* (UK) 439
S 41 *Vagir* (Ind) 409
S 41 *Santa Cruz* (Arg) 362
S 42 *San Juan* (Arg) 362
S 42 *Ursula* (UK) 439
S 42 *Vagli* (Ind) 409
S 43 *Santa Fe* (Arg) 362
S 43 *Unicorn* (UK) 439
S 43 *Vagsheer* (Ind) 409
S 44 *Santiago del Estero* (Arg) 362
S 44 *Shishumar* (Ind) 339
S 45 *Shankush* (Ind) 339
S 46 *Shalki* (Ind) 339
S 47 *Shankul* (Ind) 339
S 55 *Sindhughosh* (Ind) 396
S 56 *Sindhudhval* (Ind) 396
S 57 *Sindhuraj* (Ind) 396
S 58 *Sindhuvir* (Ind) 396
S 59 *Sindhuratna* (Ind) 396
S 60 *Sindhukesari* (Ind) 396
S 61 *Sindhukiri* (Ind) 396
S 62 *Sindhuvijay* (Ind) 396
S 71 *Galerna* (Spn) 294
S 72 *Siroco* (Spn) 294
S 73 *Mistral* (Spn) 294
S 74 *Tramontana* (Spn) 294
S 87 *Turbulent* (UK) 229
S 88 *Tireless* (UK) 229
S 90 *Torbay* (UK) 229
S 91 *Trenchant* (UK) 229
S 92 *Talent* (UK) 229
S 93 *Triumph* (UK) 229
S 97 *Maria van Riebeeck* (SA) 304
S 98 *Emily Hobhouse* (SA) 304
S 99 *Johanna van der Merwe* (SA) 304
S 101 *Shyri* (Ecu) 334
S 102 *Huancavilca* (Ecu) 334
S 104 *Sceptre* (UK) 224
S 105 *Spartan* (UK) 224
S 106 *Splendid* (UK) 224
S 107 *Trafalgar* (UK) 229
S 108 *Sovereign* (UK) 224
S 109 *Superb* (UK) 224
S 110 *Glavkos* (Gre) 336
S 111 *Nereus* (Gre) 336
S 112 *Triton* (Gre) 336
S 113 *Proteus* (Gre) 336
S 116 *Posydon* (Gre) 336
S 117 *Amphitrite* (Gre) 336
S 118 *Okeanos* (Gre) 336
S 119 *Pontos* (Gre) 336
S 131 *Hangor* (Pak) 300
S 132 *Shushuk* (Pak) 300
S 133 *Mangro* (Pak) 300
S 134 *Ghazi* (Pak) 300
S 135 *Hashmat* (Pak) 292
S 136 *Hurmat* (Pak) 292
S 137 (Pak) 292
S 138 (Pak) 292
S 139 (Pak) 292
S 163 *Albacora* (Por) 301
S 164 *Barracuda* (Por) 301
S 166 *Delfim* (Por) 301
S 170 *U 21* (Ger) 312
S 171 *U 22* (Ger) 312
S 172 *U 23* (Ger) 313
S 173 *U 24* (Ger) 313
S 174 *U 25* (Ger) 313
S 175 *U 26* (Ger) 313
S 176 *U 27* (Ger) 312
S 177 *U 28* (Ger) 313
S 178 *U 29* (Ger) 313
S 179 *U 30* (Ger) 313
S 192 *U 13* (Ger) 311
S 193 *U 14* (Ger) 311
S 194 *U 15* (Ger) 312
S 195 *U 16* (Ger) 312
S 196 *U 17* (Ger) 312
S 197 *U 18* (Ger) 312
S 198 *U 19* (Ger) 311
S 199 *U 20* (Ger) 311
S 300 *Ula* (Nor) 354
S 301 *Utsira* (Nor) 354
S 302 *Utstein* (Nor) 354
S 303 *Utvaer* (Nor) 354
S 304 *Uthaug* (Nor) 354
S 305 *Uredo* (Nor) 354
S 306 *Skolpen* (Nor) 316
S 308 *Stord* (Nor) 316
S 309 *Svenner* (Nor) 316
S 314 *Sklinna* (Nor) 316
S 318 *Kobben* (Nor) 316
S 319 *Kunna* (Nor) 317
S 320 *Narhvalen* (Den) 307
S 321 *Nordkaperen* (Den) 307
S 322 *Tumleren* (Den) 319
S 323 *Saelen* (Den) 319
S 324 *Springeren* (Den) 319
S 333 *Ikinci Inonu* (Tur) 449
S 335 *Burak Reis* (Tur) 447
S 336 *Murat Reis* (Tur) 447
S 338 *Uluc Ali Reis* (Tur) 447
S 340 *Cerbe* (Tur) 447
S 341 *Canakkale* (Tur) 449
S 342 *Hizir Reis* (Tur) 451
S 343 *Piri Reis* (Tur) 451
S 346 *Birinci Inonu* (Tur) 447
S 347 *Atilay* (Tur) 348
S 348 *Saldiray* (Tur) 348
S 349 *Batiray* (Tur) 348
S 350 *Yildiray* (Tur) 348
S 351 *Doganay* (Tur) 348
S 352 *Dolunay* (Tur) 348
S 353 *Preveze* (Tur) 350
S 354 *Sakarya* (Tur) 350
S 355 *18 Mart* (Tur) 350
S 356 *Anafartalar* (Tur) 350
S 518 *Nazario Sauro* (Ita) 365
S 519 *Fecia di Cossato* (Ita) 365
S 520 *Leonardo da Vinci* (Ita) 365
S 521 *Guglielmo Marconi* (Ita) 365
S 522 *Salvatore Pelosi* (Ita) 368
S 523 *Giuliano Prini* (Ita) 368
S 524 *Primo Longobardo* (Ita) 368
S 525 *Gianfranco Gazzana Priaroggia* (Ita) 368
S 601 *Rubis* (Fra) 195
S 602 *Saphir* (Fra) 195
S 603 *Casabianca* (Fra) 195
S 604 *Emeraude* (Fra) 195
S 605 *Améthyste* (Fra) 195
S 606 *Perle* (Fra) 195
S 610 *Le Foudroyant* (Fra) 162
S 612 *Le Terrible* (Fra) 162
S 613 *L'Indomptable* (Fra) 162
S 614 *Le Tonnant* (Fra) 162
S 615 *L'Inflexible* (Fra) 162
S 616 *Le Triomphant* (Fra) 159
S 617 *Le Téméraire* (Fra) 159
S 618 *Le Vigilant* (Fra) 159
S 619 (Fra) 159
S 620 *Agosta* (Fra) 289
S 621 *Beveziers* (Fra) 289
S 622 *La Praya* (Fra) 289
S 623 *Ouessant* (Fra) 289
S 650 *Psyche* (Fra) 298
S 651 *Sirene* (Fra) 298
S 802 *Walrus* (Ned) 383
S 803 *Zeeleeuw* (Ned) 383
S 806 *Zwaardvis* (Ned) 378
S 807 *Tijgerhaai* (Ned) 378
S 808 *Dolfijn* (Ned) 383
S 810 *Bruinvis* (Ned) 383
SS 28 *Pijao* (Col) 332
SS 29 *Tayrona* (Col) 332
SS 31 *Casma* (Per) 346
SS 32 *Antofagasta* (Per) 346
SS 33 *Pisagua* (Per) 346
SS 34 *Chipana* (Per) 346
SS 35 *Islay* (Per) 346
SS 36 *Arica* (Per) 346
SS 41 *Dos de Mayo* (Per) 387
SS 42 *Abtao* (Per) 387
SS 573 *Yuushio* (Jpn) 371
SS 574 *Mochishio* (Jpn) 371
SS 575 *Setoshio* (Jpn) 371
SS 576 *Okishio* (Jpn) 371
SS 577 *Nadashio* (Jpn) 371
SS 578 *Hamashio* (Jpn) 371
SS 579 *Akishio* (Jpn) 371
SS 580 *Takeshio* (Jpn) 371
SS 581 *Yukishio* (Jpn) 371
SS 582 *Sachishio* (Jpn) 371
SS 583 *Harushio* (Jpn) 374
SS 584 *Natsushio* (Jpn) 374
SS 585 *Hayashio* (Jpn) 374
SS 586 *Arashio* (Jpn) 374
SS 587 *Wakashio* (Jpn) 374
SS 588 *Fuyushio* (Jpn) 374
SS 589 (Jpn) 374
SS 590 (Jpn) 377
SS 591 (Jpn) 377
SSBN 726 *Ohio* (USA) 177
SSBN 727 *Michigan* (USA) 177
SSBN 728 *Florida* (USA) 177
SSBN 729 *Georgia* (USA) 177
SSBN 730 *Henry M Jackson* (USA) 177
SSBN 731 *Alabama* (USA) 177
SSBN 732 *Alaska* (USA) 177
SSBN 733 *Nevada* (USA) 177
SSBN 734 *Tennessee* (USA) 177
SSBN 735 *Pennsylvania* (USA) 177
SSBN 736 *West Virginia* (USA) 177
SSBN 737 *Kentucky* (USA) 177
SSBN 738 *Maryland* (USA) 177
SSBN 739 *Nebraska* (USA) 178
SSBN 740 *Rhode Island* (USA) 178
SSBN 741 *Maine* (USA) 178
SSBN 742 *Wyoming* (USA) 178
SSBN 743 *Louisiana* (USA) 178
SSG 73 *Collins* (Aust) 269
SSG 74 *Farncomb* (Aust) 269
SSG 75 *Waller* (Aust) 269
SSG 76 *Dechaineux* (Aust) 269
SSG 77 *Sheean* (Aust) 269
SSG 78 *Rankin* (Aust) 269
SSN 21 *Seawolf* (USA) 250
SSN 22 *Connecticut* (USA) 250
SSN 639 *Tautog* (USA) 235
SSN 642 *Kamehameha* (USA) 233
SSN 645 *James K Polk* (USA) 233
SSN 646 *Grayling* (USA) 235
SSN 647 *Pogy* (USA) 235
SSN 649 *Sunfish* (USA) 235
SSN 652 *Puffer* (USA) 235
SSN 660 *Sand Lance* (USA) 235
SSN 666 *Hawkbill* (USA) 235
SSN 667 *Bergall* (USA) 235
SSN 668 *Spadefish* (USA) 235
SSN 670 *Finback* (USA) 235
SSN 671 *Narwhal* (USA) 240
SSN 672 *Pintado* (USA) 235
SSN 673 *Flying Fish* (USA) 235
SSN 674 *Trepang* (USA) 235
SSN 675 *Bluefish* (USA) 235
SSN 676 *Billfish* (USA) 235
SSN 678 *Archerfish* (USA) 235
SSN 680 *William H Bates* (USA) 235
SSN 681 *Batfish* (USA) 235
SSN 682 *Tunny* (USA) 235
SSN 683 *Parche* (USA) 235
SSN 684 *Cavalla* (USA) 235
SSN 686 *L Mendel Rivers* (USA) 235
SSN 688 *Los Angeles* (USA) 243
SSN 690 *Philadelphia* (USA) 243

SSN 691 *Memphis* (USA) 243
SSN 694 *Groton* (USA) 243
SSN 695 *Birmingham* (USA) 243
SSN 696 *New York City* (USA) 243
SSN 697 *Indianapolis* (USA) 243
SSN 698 *Bremerton* (USA) 243
SSN 699 *Jacksonville* (USA) 243
SSN 700 *Dallas* (USA) 243
SSN 701 *La Jolla* (USA) 243
SSN 702 *Phoenix* (USA) 243
SSN 703 *Boston* (USA) 243
SSN 704 *Baltimore* (USA) 243
SSN 705 *City of Corpus Christi* (USA) 243
SSN 706 *Albuquerque* (USA) 243
SSN 707 *Portsmouth* (USA) 243
SSN 708 *Minneapolis-Saint Paul* (USA) 243
SSN 709 *Hyman G Rickover* (USA) 243
SSN 710 *Augusta* (USA) 243
SSN 711 *San Francisco* (USA) 243
SSN 712 *Atlanta* (USA) 243
SSN 713 *Houston* (USA) 243
SSN 714 *Norfolk* (USA) 243
SSN 715 *Buffalo* (USA) 244
SSN 716 *Salt Lake City* (USA) 244
SSN 717 *Olympia* (USA) 244
SSN 718 *Honolulu* (USA) 244
SSN 719 *Providence* (USA) 244
SSN 720 *Pittsburgh* (USA) 244
SSN 721 *Chicago* (USA) 244
SSN 722 *Key West* (USA) 244
SSN 723 *Oklahoma City* (USA) 244
SSN 724 *Louisville* (USA) 244
SSN 725 *Helena* (USA) 244
SSN 750 *Newport News* (USA) 244
SSN 751 *San Juan* (USA) 244
SSN 752 *Pasadena* (USA) 244
SSN 753 *Albany* (USA) 244
SSN 754 *Topeka* (USA) 244
SSN 755 *Miami* (USA) 244
SSN 756 *Scranton* (USA) 244
SSN 757 *Alexandria* (USA) 244
SSN 758 *Asheville* (USA) 244
SSN 759 *Jefferson City* (USA) 244
SSN 760 *Annapolis* (USA) 244
SSN 761 *Springfield* (USA) 244
SSN 762 *Columbus* (USA) 244
SSN 763 *Santa Fe* (USA) 244
SSN 764 *Boise* (USA) 244
SSN 765 *Montpelier* (USA) 244
SSN 766 *Charlotte* (USA) 244
SSN 767 *Hampton* (USA) 245
SSN 768 *Hartford* (USA) 245
SSN 769 *Toledo* (USA) 245
SSN 770 *Tucson* (USA) 245
SSN 771 *Columbia* (USA) 245
SSN 772 *Greeneville* (USA) 245
SSN 773 *Cheyenne* (USA) 245
V 2 *Veinticinco de Mayo* (Arg) 40

Ships' Names and Classes

Note: Ships' classes are in **bold** and ships' names in *italics*

18 Mart (Tur) 350
200 (PRC) 276
232 (PRC) 285
233 (PRC) 285
300 Let Rossiykomy (Rus) 633
342 (PRC) 285
351 (PRC) 283
352 (PRC) 285
353 (PRC) 285
354 (PRC) 285
356 (PRC) 285
357 (PRC) 285
358 (PRC) 285
359 (PRC) 285
401 (PRC) 192
402 (PRC) 192
403 (PRC) 192
404 (PRC) 192
725 (Cub) 407
727 (Cub) 407
729 (Cub) 407

A

Abraham Lincoln (USA) 74
Abtao (Per) 387
Abtao (Per) 387
Admiral Chabanenko (Rus) 626
Admiral Gorshkov (Rus) 21
Admiral Kharlamov (Rus) 626
Admiral Kuznetsov (Rus) 21
Admiral Lazarev (Rus) 478
Admiral Levchenko (Rus) 626
Admiral Lobov (Rus) 474
Admiral Nakhimov (Rus) 478
Admiral Panteleyev (Rus) 626
Admiral Spiridonov (Rus) 625
Admiral Ushakov (Rus) 478
Admiral Vinogradov (Rus) 626
Agosta (Fra) 288
Agosta (Fra) 289
Aguirre (Per) 467
Aguirre (Per) 467
Akishio (Jpn) 371
Akula (Rus) 174
Akula I (Rus) 218
Akula I Improved (Rus) 218
Akula II (Rus) 218
Alabama (USA) 177
Alamgir (Pak) 687
Alamgir (Pak) 687
Alaska (USA) 177
Albacora (Daphne) (Por) 301
Albacora (Por) 301
Albany (USA) 244
Albuquerque (USA) 243
Alcitepe (Tur) 695
Alcitepe (Tur) 695
Aleksander Nevsky (Rus) 633
Alexandria (USA) 244
Alfa (Rus) 206
Algonquin (USA) 509
Allen M Sumner (USA) 672
Almirante Grau (Per) 464
Almirante Grau (Per) 464
Almirante Riveros (Chi) 515
Almirante Williams (Chi) 515
Amagiri (Jpn) 589
America (USA) 66
Améthyste (Fra) 195
Amphitrite (Gre) 336
An Yang (RoC) 669
Anafartalar (Tur) 350
Anittepe (Tur) 695
Annapolis (USA) 244
Antietam (USA) 495
Antofagasta (Per) 346
Anzio (USA) 496
Arashio (Jpn) 374
Archerfish (USA) 235
Ardito (Ita) 554
Arica (Per) 346
Ark Royal (UK) 54
Arkansas (USA) 489
Arkhangelsk (Rus) 203
Arleigh Burke I/II (USA) 748
Arleigh Burke IIA (USA) 758
Arleigh Burke (USA) 748
Arthur W Radford (USA) 731
Asagiri (Jpn) 589
Asagiri (Jpn) 589
Asakase (Jpn) 597
Asayuki (Jpn) 584
Asheville (USA) 244
Athabaskan (USA) 509
Atilay (Tur) 348
Atilay (Tur) 348
Atlanta (USA) 243
Audace (Ita) 554
Audace (Ita) 554
Augusta (USA) 243
Azov (Rus) 470

B

Babr (Iran) 673
Babr (Iran) 673
Baltimore (USA) 243
Bangalore (Ind) 550
Baracuda (Rus) 214
Baracuda I (Rus) 214
Baracuda II (Rus) 216
Barracuda (Por) 301
Barry (USA) 748
Bars (Rus) 218
Batfish (USA) 235
Batiray (Tur) 348
Belgorod (Rus) 203
Benfold (USA) 748
Benjamin Franklin (USA) 233
Bergall (USA) 235
Bespokoiny (Rus) 633
Besstrashny (Rus) 633
Beveziers (Fra) 289
Bezboyaznenny (Rus) 633
Bezuprehny (Rus) 633
Billfish (USA) 235
Birinci Inonu (Tur) 447
Birmingham (UK) 650
Birmingham (USA) 243
Bison (Rus) 218
Bison (Rus) 222
Blanco Encalada (Chi) 644
Bluefish (USA) 235
Boise (USA) 244
Bombay (Ind) 550
Boston (USA) 243
Boyevoy (Rus) 633
Bremerton (USA) 243
Brisbane (USA) 716
Briscoe (USA) 732
Bruinvis (Nld) 383
Buffalo (USA) 244
Bunker Hill (USA) 495
Burak Reis (Tur) 447
Burny (Rus) 633
Bystry (Rus) 633

C

Cakra (Indo) 342
Cakra (Indo) 342
California (USA) 485
California (USA) 485
Callaghan (USA) 742
Canakkale (Tur) 449
Cape St George (USA) 496
Cardiff (UK) 650
Caribe (Ven) 352
Carl Vinson (USA) 74
Carney (USA) 748
Caron (USA) 731
Carpenter (USA) 676
Casabianca (Fra) 195
Casma (Per) 346
Casma (Per) 346
Cassard (Fra) 545
Cassard (Fra) 545
Cavalla (USA) 235
Cerbe (Tur) 447
Chakri Naruebet (Tld) 34
Chakri Naruebet (Tld) 34
Chancellorsville (USA) 495
Chandler (USA) 742
Chang Bogo (RoK) 344
Chang Bogo (RoK) 344
Changsha (PRC) 521
Charles de Gaulle (Fra) 8
Charles de Gaulle (Fra) 8
Charles F Adams (USA) 715
Charlie II (Rus) 201
Charlotte (USA) 244
Chelyabinsk (Rus) 203
Chen Yang (RoC) 711
Cheyenne (USA) 245
Chicago (USA) 244
Chien Yang (RoC) 711
Chipana (Per) 346
Choi Muson (RoK) 344
Chongqing (PRC) 521
Chosin (USA) 495
Chung Buk (RoK) 679
Chung Buk (RoK) 679
City of Corpus Christi (USA) 243
Clemenceau (Fra) 3
Clemenceau (Fra) 3
Cochrane (Chi) 644
Cole (USA) 748
Collins (Aust) 269
Collins (Aust) 269
Colossus (Arg/Brz) 40, 43
Columbia (USA) 245
Columbus (USA) 244
Comte de Grasse (USA) 732
Connecticut (USA) 250
Conolly (USA) 732
Constellation (USA) 66
Cougar (Rus) 218
Cowpens (USA) 495
Cuitlahuac (Mex) 667
Cuitlahuac (Mex) 667
Curtis Wilbur (USA) 748
Cushing (USA) 732

D

Dalian (PRC) 521
Dallas (USA) 243
Dang Yang (RoC) 707
Daphne (Fra) 297
Daquingyu (PRC) 157
David R Ray (USA) 731
Dechaineux (Aust) 269
De Grasse (Fra) 527
De La Penne (Ita) 560
Decatur (USA) 749
Delfim (Por) 301
Delfin (Rus) 172
Delfin (Spn) 297
Delfinul (Rom) 401
Delhi (Ind) 550
Delhi (Ind) 550
Delta I (Rus) 165
Delta II (Rus) 167
Delta III (Rus) 169
Delta IV (Rus) 172
Deyo (USA) 732
Doganay (Tur) 348
Dolfijn (Nld) 383
Dolphin (Isr) 360
Dolunay (Tur) 348
Donald Cook (USA) 749
Dos de Mayo (Per) 387
Dragon (Rus) 218
Drava (Yug) 455
Duguay-Trouin (Fra) 527
Dupleix (Fra) 538
Duquesne (Fra) 532
Dwight D Eisenhower (USA) 74

E

Echo II (Rus) 199
Edinburgh (UK) 656
El Fateh (Egy) 638
El Fateh (Egy) 638
El Hadj Slimane (Alg) 394
Elliott (USA) 731
Emeraude (Fra) 195
Emily Hobhouse (SA) 304
Enterprise (USA) 70
Enterprise (USA) 70
Exeter (UK) 650

F

Farncomb (Aust) 269
Fecia di Cossato (Ita) 365
Ferre (Per) 640
Ferre (Per) 640

Fife (USA) 732
Finback (USA) 235
Fitzgerald (USA) 748
Fletcher (USA) 666
Fletcher (USA) 732
Florida (USA) 177
Flying Fish (USA) 235
Foch (Fra) 3
Formion (Gre) 727
Forrestal (USA) 61
Forrestal (USA) 61
Foxtrot (Cub) 407
Foxtrot (Ind) 408
Foxtrot (Rus) 406
Francesco Mimbelli (Ita) 560
Fu Yang (RoC) 702
Fuyushio (Jpn) 374

G

Gal (Isr) 309
Gal (Isr) 309
Galerna (Agosta) (Spn) 294
Galerna (Spn) 294
Gearing (USA) 676
George Washington (USA) 74
Georges Leygues (Fra) 538
Georges Leygues (Fra) 538
Georgia (USA) 177
Gepard (Rus) 218
Gettysburg (USA) 495
Gianfranco Gazzano Priaroggia (Ita) 368
Giuliano Prini (Ita) 368
Giuseppe Garibaldi (Ita) 16
Giuseppe Garibaldi (Ita) 16
Glasgow (UK) 650
Glavkos (Gre) 336
Glavkos (Gre) 336
Gloucester (UK) 656
Golf (PRC) 276
Gonzalez (USA) 748
Gotland (Swe) 425
Gotland (Swe) 425
Grayling (USA) 235
Greeneville (USA) 245
Gremyashchy (Rus) 633
Grosha (Rus) 220
Groton (USA) 243
Guglielmo Marconi (Ita) 365
Guilin (PRC) 521
Guppy II (RoC) 445
Guppy IIA (Tur) 447
Guppy III (Tur) 449

H

Hai Bao (RoC) 445
Hai Hu (RoC) 380
Hai Lung (RoC) 380
Hai Lung (RoC) 380
Hai Shih (RoC) 445
Halland (Swe) 425
Hälsingland (Swe) 422
Hamagiri (Jpn) 589
Hamashio (Jpn) 371
Hamayuki (Jpn) 584
Hampton (USA) 245
Han (PRC) 192
Han Yang (RoC) 707
Hangor (Daphne) (Pak) 299
Haribing (PRC) 518
Harry S Truman (USA) 75
Harry W Hill (USA) 732
Hartford (USA) 245
Haruna (Jpn) 572
Haruna (Jpn) 572
Harusame (Jpn) 594
Harushio, Improved (Jpn) 377
Harushio (Jpn) 374
Harushio (Jpn) 374
Haruyuki (Jpn) 584
Hashmat (Agosta) (Pak) 292
Hashmat (Pak) 292
Hatakase (Jpn) 601
Hatakase (Jpn) 601
Hatsuyuki (Jpn) 584
Hatsuyuki (Jpn) 584
Hawkbill (USA) 235
Hayashio (Jpn) 374
Hayler (USA) 732
Hefei (PRC) 521
Helena (USA) 244
Henry M Jackson (USA) 177
Hercules (Arg) 662
Hercules (Arg) 662
Hermes (Ind) 50
Heroj (Yug) 453
Heroj (Yug) 453
Hewitt (USA) 731
Hiei (Jpn) 572
Higgins (USA) 749
Hizir Reis (Tur) 451
Hobart (USA) 716
Honolulu (USA) 244
Hopper (USA) 749
Houston (USA) 243
Huancavilca (Ecu) 334
Hue City (USA) 495
Humaita (Brz) 433
Hurmat (Pak) 292
Huron (USA) 509
Hyatt (Chi) 437
Hyman G Rickover (USA) 243

I

Ikinci Inonu (Tur) 449
Ilhuicamina (Mex) 684
Ilhuicamina (Mex) 684
Illustrious (UK) 54
Independence (USA) 61
Indianapolis (USA) 243
L'Indomptable (Fra) 162
L'Inflexible (Fra) 162
L'Inflexible (Fra) 162
Ingersoll (USA) 732
Invincible (UK) 54
Invincible (UK) 54
Iroquois (USA) 509
Iroquois (USA) 509
Islay (Per) 346
Isoyuki (Jpn) 584

J

Jacksonville (USA) 243
James K Polk (USA) 233
Jaguar (Rus) 218
Jean Bart (Fra) 545
Jean de Vienne (Fra) 538
Jefferson City (USA) 244
Jeon Buk (RoK) 679
Jeon Ju (RoK) 680
Jinan (PRC) 521
Johanna van der Merwe (SA) 304
John C Stennis (USA) 74
John F Kennedy (USA) 66
John F Kennedy (USA) 66
John Hancock (USA) 732
John Paul Jones (USA) 748
John Rodgers (USA) 732
John S McCain (USA) 748
John Young (USA) 732

K

K 18 (Rus) 172
K 44 (Rus) 169
K 51 (Rus) 172
K 64 (Rus) 172
K 84 (Rus) 172
K 92 (Rus) 167
K 114 (Rus) 172
K 117 (Rus) 172
K 129 (Rus) 169
K 138 (Rus) 212
K 180 (Rus) 169
K 193 (Rus) 167
K 211 (Rus) 169
K 218 (Rus) 212
K 223 (Rus) 169
K 242 (Rus) 212
K 244 (Rus) 212
K 247 (Rus) 212
K 251 (Rus) 212
K 254 (Rus) 212
K 255 (Rus) 212
K 263 (Rus) 218
K 264 (Rus) 212
K 292 (Rus) 212
K 298 (Rus) 212
K 299 (Rus) 212
K 305 (Rus) 212
K 322 (Rus) 218
K 324 (Rus) 212
K 355 (Rus) 212
K 358 (Rus) 212
K 360 (Rus) 212
K 388 (Rus) 212
K 403 (Rus) 220
K 407 (Rus) 172
K 412 (Rus) 212
K 414 (Rus) 212
K 418 (Rus) 220
K 421 (Rus) 167
K 422 (Rus) 220
K 424 (Rus) 169
K 441 (Rus) 169
K 448 (Rus) 212
K 449 (Rus) 169
K 455 (Rus) 169
K 487 (Rus) 169
K 490 (Rus) 169
K 492 (Rus) 212
K 496 (Rus) 169
K 502 (Rus) 212
K 506 (Rus) 169
K 507 (Rus) 212
K 524 (Rus) 212
K 527 (Rus) 212
KK 530 (Rus) 203
Kai Yang (RoC) 707
Kaifeng (PRC) 521
Kalmar (Rus) 169
Kamehameha (USA) 233
Kang Won (RoK) 680
Kara (Rus) 470
Karanj (Ind) 409
Kasatka (Rus) 203
Kashin (Rus) 613
Kefal I (Rus) 208
Kefal II (Rus) 210
Kentucky (USA) 177
Kerch (Rus) 470
Key West (USA) 244
Kidd (USA) 742
Kidd (USA) 742
Kiev modified (Rus) 21
Kikusuki (Jpn) 580
Kilic Ali Pasa (Tur) 691
Kilo (Alg) 393
Kilo (Ind) 396
Kilo (Iran) 398
Kilo (Pol) 399
Kilo (PRC) 395
Kilo (Rom) 401
Kilo (Rus) 391
Kimon (Gre) 727
Kimon (Gre) 727
Kinkaid (USA) 731
Kirishima (Jpn) 605
Kirov (Rus) 478
Kitty Hawk (USA) 66
Kitty Hawk (USA) 66
Kobben (modernised) (Nor) 316
Kobben (Nor) 316
Kondor (Rus) 212
Kongo (Jpn) 605
Kongo (Jpn) 605
Krasnodar (Rus) 203
Kun Yang (RoC) 669
Kunna (Nor) 317
Kurama (Jpn) 576
Kursk (Rus) 203
Kursura (Ind) 409
Kuznetsov (Rus) 25
Kwei Yang (RoC) 669
Kwei Yang (RoC) 669
Kwang Ju (RoK) 680
Kyong Ki (RoK) 680

L

L Mendel Rivers (USA) 235
La Jolla (USA) 243
La Motte-Picquet (Fra) 539
Laboon (USA) 748
Lai Yang (RoC) 707
Lake Champlain (USA) 495
Lake Erie (USA) 496
Latorre (Chi) 644
Latouche-Treville (Fra) 539
Lee Jongmu (RoK) 344
Le Foudroyant (Fra) 162
Leftwich (USA) 732
Leonardo da Vinci (Ita) 365
Leopard (Rus) 218
Le Temeraire (Fra) 159
Le Terrible (Fra) 162
Le Tonnant (Fra) 162
Le Triomphant (Fra) 159
Le Triomphant (Fra) 159
Le Vigilant (Fra) 159
Leyte Gulf (USA) 495
Liao Yang (RoC) 711
Liverpool (UK) 650
Los Angeles (USA) 243
Los Angeles (USA) 243
Louisiana (USA) 178
Louisville (USA) 244
Luda (PRC) 521
Luhu (PRC) 518
Luigi Durand De La Penne (Ita) 560

Lütjens (Ger) 721
Lütjens (Ger) 721

M

Mahan (USA) 749
Maine (USA) 178
Majestic (Ind) 47
Manchester (UK) 656
Marasesti (Jpn) 610
Marasesti (Jpn) 610
Maria van Riebeeck (SA) 303
Maria van Riebeeck (SA) 304
Marshal Shaposhnikov (Rus) 625
Marshal Ustinov (Rus) 474
Marshal Vasilevsky (Rus) 625
Maryland (USA) 177
Matsuyuki (Jpn) 584
McFaul (USA) 749
Memphis (USA) 243
Merrill (USA) 732
Miami (USA) 244
Michigan (USA) 177
Milius (USA) 749
Minas Gerais (Brz) 43
Minegumo (Jpn) 569
Mineyuki (Jpn) 584
Ming (PRC) 285
Minneapolis-St Paul (USA) 243
Mississippi (USA) 489
Mistral (Spn) 294
Mitscher (USA) 748
Mobile Bay (USA) 495
Mochishio (Jpn) 371
Mölders (Ger) 721
Montcalm (Fra) 538
Monterey (USA) 495
Montpelier (USA) 244
Moosbrugger (USA) 732
Moskva (Rus) 474
Murakumo (Jpn) 569
Murasame (Jpn) 594
Murasame (Jpn) 594
Murat Reis (Tur) 447
Murena (Rus) 165
Murena-M (Rus) 167
Murmansk (Rus) 203
Myoko (Jpn) 605
Mysore (Ind) 550

N

Nadashio (Jpn) 371
Nadezhda (Bul) 278
Näcken (Swe) 416
Näcken (Modified) (Swe) 419
Näcken (Swe) 419
Najad (Swe) 416
Nan Yang (RoC) 702
Nanchang (PRC) 521
Nanggala (Indo) 342
Nanjing (PRC) 521
Nanning (PRC) 521
Narhvalen (Den) 307
Narhvalen (Den) 307
Narwhal (USA) 240
Narwhal (USA) 240
Nastoychivy (Rus) 633
Natsushio (Jpn) 374
Nazario Sauro (Ita) 365
Nearchos (Gre) 727
Nebraska (USA) 178
Neptun (Swe) 416
Nereus (Gre) 336
Netzahualcoyotl (Mex) 684
Nevada (USA) 177
New York City (USA) 243
Newcastle (UK) 650
Newport News (USA) 244
Nicholson (USA) 732
Nimitz (USA) 74
Nimitz (USA) 74
Noor (Iran) 398
Nordkaperen (Den) 307
Norfolk (USA) 243
Normandy (USA) 495
Nottingham (UK) 650

O

Oberon 430
O'Bannon (USA) 732
O'Brien (Chi) 436
O'Brien (Chi) 437
O'Brien (USA) 732
Ochakov (Rus) 470
Ohio (USA) 177
Ohio (USA) 177
Ojibwa (Can) 434
Ojibwa (Can) 435
Okanagan (Can) 435
O'Kane (USA) 749
Okeanos (Gre) 336
Okishio (Jpn) 371
Oklahoma City (USA) 244
Okrylenny (Rus) 633
Okun (Rus) 216
Oldendorf (USA) 732
Olympia (USA) 244
Omsk (Rus) 203
Onondaga (Can) 435
Onslow (Aust) 431
Onslow (Aust) 431
Orel (Rus) 203
Orion (Aust) 431
Orzel (Pol) 399
Oscar (Rus) 203
Oscar Austin (USA) 758
Osmotritelny (Rus) 633
Östergötland (Swe) 422
Otama (Aust) 431
Otlichnny (Rus) 633
Ouessant (Fra) 289

P

Pakui (RoK) 344
Palang (Iran) 673
Panther (Rus) 218
Parche (USA) 235
Paul F Foster (USA) 731
Paul Hamilton (USA) 748
Pekov (Rus) 203
Pennsylvania (USA) 177
Perle (Fra) 195
Perth (USA) 716
Perth (USA) 716
Peterson (USA) 731
Petropavlovsk (Rus) 470
Philadelphia (USA) 243
Philippine Sea (USA) 495
Phoenix (USA) 243
Pijao (Col) 332
Pijao (Col) 332
Pintado (USA) 235
Piri Reis (Tur) 451
Pisagua (Per) 346
Pittsburg (USA) 244
Piyale Pasa (Tur) 691
Pogy (USA) 235
Pontos (Gre) 336
Port Royal (USA) 496
Porter (USA) 749
Portsmouth (USA) 243
Posydon (Gre) 336
Prat (Chi) 643
Prat (Chi) 644
La Praya (Fra) 289
Preveze (Tur) 350
Preveze (Tur) 350
Primauguet (Fra) 538
Primo Longobardo (Ita) 368
Princeton (USA) 495
Principe de Asturias (Spn) 29
Principe de Asturias (Spn) 29
Proteus (Gre) 336
Providence (USA) 244
Psyche (Fra) 298
Puffer (USA) 235
Puma (Rus) 218
Pyotr Velikiy (Rus) 478

Q

Qingdao (PRC) 518

R

Rahav (Isr) 309
Rais Hadj Mubarek (Alg) 394
Rajput (Kashin II) (Ind) 617
Rajput (Ind) 617
Ramage (USA) 748
Rana (Ind) 617
Ranger (USA) 61
Ranjit (Ind) 617
Rankin (Aust) 269
Ranvijay (Ind) 617
Ranvir (Ind) 617
Rastoropny (Rus) 633
Rhode Island (USA) 178
Riachuelo (Brz) 433
Romeo (Bul) 278
Romeo (converted)/ES5G (PRC) 283
Romeo (Egy) 279
Romeo (DPRK) 281
Romeo (PRC) 277
Romeo (Syr) 282
Rommel (Ger) 721
Ronald Reagan (USA) 75
Ross (USA) 749
Rubis Améthyste (Fra) 195
Rubis (Fra) 195
Russell (USA) 748
Rys (Rus) 218

S

Sabalo (Ven) 352
Sabalo (Ven) 352
Sachishio (Jpn) 371
Sadena (USA) 244
Saelen (Den) 319
Sakarya (Tur) 350
Saldiray (Tur) 348
Salt Lake City (USA) 244
Salta (Arg) 325
Salta (Arg) 325
Salvatore Pelosi (Ita) 368
San Francisco (USA) 243
San Jacinto (USA) 495
San Juan (Arg) 362
San Juan (USA) 244
San Luis (Arg) 325
Sand Lance (USA) 235
Santa Cruz (Arg) 362
Santa Cruz (Arg) 362
Santa Fe (Arg) 362
Santa Fe (USA) 244
Santiago (Arg) 362
Santisima Trinidad (Arg) 662
Saphir (Fra) 195
Saratoga (USA) 61
Sauro, Improved (Ita) 368
Sauro (Ita) 365
Sava (Yug) 455
Sava (Yug) 455
Sawagiri (Jpn) 589
Sawakase (Jpn) 597
Sawayuki (Jpn) 584
Sceptre (UK) 224
Scott (USA) 742
Scranton (USA) 244
Sderzhanny (Rus) 613
Seawolf (USA) 250
Seawolf (USA) 250
Setogiri (Jpn) 589
Setoshio (Jpn) 371
Setoyuki (Jpn) 584
Severomorsk (Rus) 625
Shalki (Ind) 339
Shankul (Ind) 339
Shankush (Ind) 339
Shao Yang (RoC) 711
Sheean (Aust) 269
Shen Yang (RoC) 711
Shiloh (USA) 496
Shimakase (Jpn) 601
Shimayuki (Jpn) 584
Shirane (Jpn) 576
Shirane (Jpn) 576
Shirayuki (Jpn) 584
Shishumar (Ind) 339
Shishumar (Ind) 339
Shuei Yang (RoC) 702
Shyri (Ecu) 334
Shyri (Ecu) 334
Sierra I (Rus) 214
Sierra II (Rus) 216
Simpson (Chi) 330
Sindhudhvaj (Ind) 396
Sindhughosh (Ind) 396
Sindhukesari (Ind) 396
Sindhukiri (Ind) 396
Sindhuraj (Ind) 396
Sindhuratna (Ind) 396
Sindhuvijay (Ind) 396
Sindhuvir (Ind) 396
Sir Winston Churchill (USA) 758
Sirene (Fra) 298
Siroco (Spn) 294
Skat M (Rus) 201
Sklinna (Nor) 316
Skolpen (Nor) 316
Skory (Rus) 613
Slava (Bul) 278
Slava (Rus) 474
Smolensk (Rus) 203
Severodvinsk (Rus) 222
Sobrazitelny (Rus) 633
Södermanland (Swe) 422
South Carolina (USA) 485
Southampton (UK) 650

Sovereign (UK) 224
Sovremenny (Rus) 632
Sovremenny (Rus) 633
Spadefish (USA) 235
Spartan (UK) 224
Splendid (UK) 224
Springfield (USA) 244
Springeren (Den) 319
Spruance (USA) 731
Spruance (USA) 731
Stethem (USA) 748
Stoyky (Rus) 633
Strod (Nor) 316
Stump (USA) 732
Sturgeon (USA) 235
Suffren (Fra) 532
Suffren (Fra) 532
Sunfish (USA) 235
Superb (UK) 224
Svenner (Nor) 316
Swiftsure (UK) 224

T

Tachikase (Jpn) 597
Tachikase (Jpn) 597
Taejon (RoK) 679
Taimur (Pak) 687
Takatsuki (Jpn) 580
Takatsuki (Jpn) 580
Takeshio (Jpn) 371
Talent (UK) 229
Tamandare (Brz) 274
Tamoio (Brz) 328
Tang (Tur) 451
Tango (Rus) 403
Tanin (Isr) 309
Tapajos (Brz) 328
Tareq (Iran) 398
Tautog (USA) 235
Tayrona (Col) 332
Te Yang (RoC) 711
Tennessee (USA) 177
The Sullivans (USA) 749
Themistocles (Gre) 727
Theodore Roosevelt (USA) 74
Thomas S Gates (USA) 495
Thomson (Chi) 330
Thomson (Chi) 330
Thorn (USA) 732
Ticonderoga (USA) 495
Ticonderoga (USA) 495
Tiger (Rus) 218
Tijgerhaai (Nld) 378
Timbira (Brz) 328
Tireless (UK) 229
TK 12 (Rus) 174
TK 13 (Rus) 174
TK 17 (Rus) 174
TK 20 (Rus) 174
TK 202 (Rus) 174
TK 208 (Rus) 174
Toledo (USA) 245
Tomsk (Rus) 203
Toncantins (Brz) 274
Tonelero (Brz) 433
Topeka (USA) 244
Torbay (UK) 229
Tourville (Fra) 527
Tourville (Fra) 527
Trafalgar Batch 1 (UK) 229
Trafalgar (UK) 229
Tramontana (Spn) 294
Trenchant (UK) 229
Trepang (USA) 235
Triton (Gre) 336
Triumph (UK) 229
Tucson (USA) 245
Tughril (Pak) 687
Tumleren (Den) 319
Tumleren (Den) 319
Tunny (USA) 235
Tupi (Brz) 328
Tupi, Improved (Brz) 274
Tupi (Brz) 328
Turbulent (UK) 229
Type 42 Batches 1/2 (UK) 650
Type 42 Batch 3 (UK) 656
Type 206/206A (Ger) 311
Type 209/1100 (Gre) 323
Type 209/1200 (Arg, Col, Gre, Per, RoK, Tur) 323
Type 209/1300 (Chi, Ecu, Indo, Ven) 323
Type 209/1400 (Brz, Tur) 323
Type 209/1500 (Ind) 323
Type 212 (Ger) 357
Typhoon (Rus) 174

U

U 13 (Ger) 311
U 14 (Ger) 311
U 15 (Ger) 312
U 16 (Ger) 312
U 17 (Ger) 312
U 18 (Ger) 312
U 19 (Ger) 311
U 20 (Ger) 311
U 21 (Ger) 312
U 22 (Ger) 312
U 23 (Ger) 313
U 24 (Ger) 313
U 25 (Ger) 313
U 26 (Ger) 313
U 27 (Ger) 312
U 28 (Ger) 313
U 29 (Ger) 313
U 30 (Ger) 313
U 31 (Ger) 357
U 32 (Ger) 357
U 33 (Ger) 357
U 34 (Ger) 357
Udaloy (Rus) 625
Udaloy (Rus) 625
Ula (Nor) 354
Ula (Nor) 354
Uluc Ali Reis (Tur) 447
Umigiri (Jpn) 589
Unicorn (UK) 439
Unseen (UK) 439
Upholder (UK) 439
Upholder (UK) 439
Uppland (Swe) 425
Uredd (Nor) 354
Ursula (UK) 439
Uskok (Yug) 453
Utharg (Nor) 354
Utsira (Nor) 354
Utstein (Nor) 354
Utvaer (Nor) 354

V

Vagir (Ind) 409
Vagli (Ind) 409
Vagsheer (Ind) 409
Valley Forge (USA) 495
Vanguard (UK) 182
Vanguard (UK) 182
Varyag (Rus) 474
Västergötland (Swe) 422
Västergötland (Swe) 422
Veinticinco de Mayo (Arg) 40
Vela (Ind) 409
Vella Gulf (USA) 496
Vengeance (UK) 182
Vepr (Rus) 218
Veronesh (Rus) 203
Vicksburg (USA) 496
Victor I (Rus) 208
Victor II (Rus) 210
Victor III (Rus) 212
Victorious (UK) 182
Vigilant (UK) 182
Vikrant (Ind) 47
Vincennes (USA) 495
Viraat (Ind) 50
Virginia (USA) 489
Vitse-Admiral Kulakov (Rus) 625
Vittorio Veneto (Ita) 459
Vittorio Veneto (Ita) 459
Vladivostok (Rus) 470

W

Wakashio (Jpn) 374
Waller (Aust) 269
Walrus (Nld) 383
Walrus (Nld) 383
Warszawa (Pol) 621
Warszawa (Pol) 621
West Virginia (USA) 177
William H Bates (USA) 235
Wolf (Rus) 218
Wu Chin I (RoC) 701
Wu Chin II (RoC) 707
Wu Chin III (RoC) 711
Wyoming (USA) 178

X

Xia (PRC) 157
Xian (PRC) 521
Xining (PRC) 521

Y

Yamagiri (Jpn) 589
Yamayuki (Jpn) 584
Yankee Notch (Rus) 220
Yi Chon (RoK) 344
Yildiray (Tur) 348
Yinchuan (PRC) 521
York (UK) 656
Yorktown (USA) 495
Yucetepe (Tur) 691
Yucetepe (Tur) 691
Yukishio (Jpn) 371
Yun Yang (RoC) 711
Yuugiri (Jpn) 589
Yuushio (Jpn) 371
Yuushio (Jpn) 371

Z

Zeeleeuw (Nld) 383
Zhanjiang (PRC) 521
Zhuhai (PRC) 521
Zubatka (Rus) 216
Zunyi (PRC) 521
Zwaardvis (Nld) 378
Zwaardvis (Nld) 378

Sensors Index

2100 series optronic surveillance 653, 660

A

ACDS tactical data system 62, 67, 71, 76, 718, 744, 753
ADAWS action data automation 56, 652, 659, 664
ADC expendable decoy 179, 233, 237, 241, 247
Aegis Mk 7 weapon control system 499, 607, 753, 761
Aegis Mk 8 weapon control system 754, 761
Aegis display system Mk 2 ..... 754, 761
AIDCOMER command support system 5, 11
AIMS AS-3134/UPX-29 ..... 754, 762
AIO tactical data system 709
Ajanta ESM 551
Amber Light ESM 219
AN/BPS-15 search radar 179
AN/BQQ-6 sonar 179
AN/BSY-2 combat data system 251
AN/SLQ-25 Nixie decoy system 17, 29, 62, 66, 70, 75, 487, 491, 498, 510, 563, 592, 595, 607, 718, 737, 744, 753
AN/SLQ-30 ECM 510
AN/SLQ-32 ESM 62, 66, 70, 75, 486, 491, 498, 729, 737, 744, 752
AN/SLQ-39 decoy 737
AN/SLQ-501 ESM 510
AN/SPG-51 missile fire control 725, 730
AN/SPG-53 GFCS 730
AN/SPG-60 fire-control radar 725
AN/SPG-53 GFCS radar 719
AN/SPQ-9 GFCS radar 725
AN/SPS-10 search radar 674, 725, 730
AN/SPS-29 air search radar 674
AN/SPS-40 air search radar 671, 719, 725, 730
AN/SPS-52 LR air search radar 719, 725, 730
AN/SPS-58 search radar 671
AN/SPS-64 navigation radar 512, 754, 761
AN/SPS-67 navigation/search radar 719, 754, 761
AN/SPY-1D radar 608, 753, 761
AN/SQQ-23 PAIR sonar 730
AN/SQQ-28 sonar 502, 608, 740, 755, 762
AN/SQQ-89(V)6/8 ASW system 740, 755, 762
AN/SQR-18 sonar 582, 587, 592, 596
AN/SQR-19 sonar 502, 740
AN/SQS-23 sonar 689, 693, 697, 705, 719, 730
AN/SQS-26CX sonar 488
AN/SQS-43/44 sonar 674
AN/SQS-53A sonar 493, 502, 740, 745, 755, 762
AN/SQS-501 sonar 513
AN/SQS-505 sonar 5, 512
AN/SRD-503 ESM 510
AN/SRS-1 COMBAT DF 753
AN/SSQ-108(V)2 ECM 487, 491, 737
AN/SWG-1A Harpoon launch control ... 738, 744, 754, 761
AN/SWY-1 fire-control system 739
AN/SYQ-17 RAIDS anti-missile system 739
AN/SYS-1 data fusion system 730
AN/SYS-2(V)2 data fusion system 488, 493, 745
AN/UYC-501 SHINPADS combat system 511
AN/WLQ-4 ESM 251
AN/WLR-1 ESM/ECM 674
AN/WLR-8 ESM 179
AN/WLR-10 ESM 179
APECS II ESM/ECM 689
AR-680/681 ESM/ECM 670
AR-700-S5 ESM 337, 378, 384, 423
AR 740 ESM DF 270
Arabel fire-control radar 12
ARBB 32 ECM 529, 540
ARBB 33 ECM 4, 11, 534, 547
ARBR 16 ESM 529
ARBR 17 ESM suite 4, 10, 534, 540, 546
Argo 10 gun control 462
ARUR/ARUD ESM system 290, 300, 302, 305
AWS-1 air search radar 517, 641
AWS-4 search radar 44

B

Bald Head ESM 204, 206
Band Stand surveillance radar 552
Barricade ECM 645
Bass Tilt fire-control radar 22, 472, 476, 481, 552, 615, 619, 623, 630, 636
Bean Stick air search radar 524
Bell Clout/Slam/Tap 619
Bell Crown weapon control 629
Bell Shroud ESM/ECM 615, 619, 622, 628
Bell Squat ECM 615, 619, 622, 628
Big Net LR air search radar 615, 619, 623
BLD 727 ESM 365, 368
BM-8610 ESM/ECM 519
BPS 12 search radar 451
BPS-14 search/nav radar 238
BPS-15 search/nav radar 234, 238, 241, 247
BPS-16 search/nav radar 247, 251
BQG 4 sonar 451
BQG-5 WAA sonar 248, 251
BQQ-2 sonar 238
BQQ-5 sonar 238, 241, 248
BQR-2 sonar 445, 447, 449, 451
BQR-7 sonar 234
BQR-15 sonar 234
BQR-19 (Top Hat) sonar 234
BQR-21 sonar 234
BQR-23/-25 STASS sonar 248
BQS-4 sonar 234, 445, 447, 449, 451
BQS-8 sonar 241
BQS-14 sonar 238
BQS-15 sonar 248
Brick Group ESM 165, 167, 170, 172, 208
Brick Pulp ESM 199, 202, 206, 210, 212, 220
Brick Spit ESM 202, 206, 210, 212, 220
BSY-1 combat data system 247
Bull Horn sonar 476, 637
Bull Nose sonar 472, 615

C

CAAIS action data automation 51
Cage Flask ECM 629
Cake Stand radar 22
Calypso II search radar 326, 332, 334, 337, 347, 349
Calypso III search radar 274, 329
Calypso IV search radar 160, 163, 363
CASTOR 1 fire-control radar 529
CASTOR 2C fire-control radar 520, 524, 542
CCS Mk 1 combat data system 237, 247
CCS Mk 2 combat data system 179
CDS Mk 2 761
CH 74 attack periscope 385, 434, 436, 438
CH 81 attack periscope 366
CH 93 attack periscope 271
Chang Feng III ESM/ECM 704, 708, 713
CK 24 search periscope 385, 434, 436, 438
CK 31 search periscope 366
CK 38 periscope 423
CK 43 search periscope 271
Corvus chaff launcher 50
CR-201 decoy launcher 704, 708, 713
Cross Slot air search radar 524
Cross Sword fire-control radar 22, 26, 482, 630
Crotale fire-control radar 529
CSU 3-2 sonar 333, 334, 343, 347, 349, 353
CSU 3-4 sonar 326, 331, 363, 432
CSU-83/1 sonar 280, 318, 329, 337, 340, 345, 352, 355, 358, 418, 420
CSU 90 sonar 361, 427, 434, 438
CWE-10N sonar 468
CWE-610 sonar 466, 559

D

DA-02 search radar 468
DA-05 search radar 48
DA-08 search radar 41, 466
DAGAIE ECM 535, 541, 547
Dardo CIWS 462, 557, 563
DBQS-21F sonar 275, 280, 314, 355, 358
DBQS-40 sonar 358
DE 1160 sonar 19
DE 1164 sonar 563
Decca 904 navigation radar 67, 71, 76
Decca 916 search radar 639
Decca 1226 search radar 5, 529, 536, 542, 641
Decca 1229 navigation radar 548
Decca 1290 navigation radar 524
Decca 1629 navigation radar 517
DIBC 1A PIRANHA III IR tracker 541
DIBV 1A VAMPIR 10, 540, 547
DLA 2A weapon control 291
DLT D3 torpedo control 298, 303
DLT L4/5 torpedo fire control 542
DMUX 20 sonar 197
DMUX 80 sonar 160
Don Kay navigation radar 472, 619
DR 2000U ESM 314, 326, 334, 342
DR 3000U ESM receiver 160, 163, 196
DR 4000U ESM receiver 274, 329
DRBC 32 radar 5, 529, 542
DRBC 33 fire-control radar 520, 536, 542, 548
DRBI 10 height-finder radar 5
DRBI 23 air search radar 536
DRBJ 11 B/D/E air search radar 12, 548
DRBN 32 navigation radar 529, 536, 542
DRBN 34 navigation radar 548
DRBR 51 MASURCA fire control 536
DRBV 15 search radar 5, 12, 519, 536, 542
DRBV 23B air search radar 5
DRBV 26D air search radar 12, 529, 542, 548
DRBV 51 air search radar 529, 542
DRUA 31 radar 300
DRUA 33 surveillance radar 197, 274, 291, 293, 295, 298, 305, 314, 363
Drum Tilt fire-control radar 611, 619
DSBV 61A sonar 543
DSQS-21CZ sonar 671, 705, 710, 725
DSUV 1 sonar 300
DSUV 2 sonar 298, 303, 305
DSUV 22 sonar 291, 295
DSUV 62 sonar 197, 291, 296
DUBA 25A sonar 548
DUBV 23 sonar 536, 542
DUBV 43 sonar 536, 543
DUUA 1 sonar 293, 300
DUUA 2 sonar 197, 291, 295, 299, 303, 305
DUUG 1 sonar 326, 445, 445
DUUX 2 sonar 291, 295, 299, 305, 314, 326, 335, 337, 353
DUUX 5 sonar 192, 197, 278, 295, 340, 363, 385

E

ECB-680 communications buoy 226
ECB-699 communications buoy 226
EDO 900 sonar 314
EDO 1110 flank array 310
EFR 1 fire-control radar 520
Eledone sonar 378
EL/M 2208 search radar 709
EL/M-2221GM fire-control radar 647
ESR 1 search radar 520, 524
Eye Bowl fire-control radar 630
Eye Shield search radar 524

F

FAS 3-1 sonar 358
Fenelon DUUX-5 sonar 192, 278, 295, 340, 363
Feniks sonar 276, 281, 284, 285, 407
FH-5 DF 664
Fin Curve navigation radar 524
FL 1800S ESM/ECM 723
FL 1800U ESM/DF 357
Fly Screen A Tacan 472, 629
Fly Trap aircraft control radar 22, 26
FMS 52 sonar 358
Foot Ball ESM 481, 628, 635
Front Dome fire-control radar 636
Front Piece/Door FCS antennas 199

G

GI 738 decoy 664
Graseby 750 sonar 48
Guardian Type 675 ESM 55
GWS 30 weapon control 653, 659

H

H-930 weapon control 670, 704, 709, 713
Half Cup ECM 628, 635
Harpoon launch control 738, 744, 754, 761
Hawk Screech fire-control radar 611
Head Light fire-control radar 472
Head Net C search radar 472, 615, 619, 622
Herkules sonar 278, 279, 280, 407, 455
High Pole IFF 472
Horse Jaw sonar 27, 483, 630
Horse Tail sonar 483, 630
Hot Flash fire-control radar 26, 482
HR-76 fire-control radar 671, 705, 709

I

Indra search radar 553
IPD70/S sonar 366, 369
IPN-10 data handling system 47
IRIS M IR sensor 12
ISUS combat system 344, 352, 353, 361

K

KAFS fire control 274, 329
Kanaris fire control 337
Karriwarra towed array sonar 271, 432
Kingfisher sonar 762
Kite Screech fire-control radar 22, 476, 482, 630, 636
Kung Feng-6 ECM 670

L

LAD decoy system 4, 11, 536, 547
LIROD 8 weapon control 465, 467, 512
LN-66 navigation radar 488, 674, 685, 730
LW 02 air search radar 468
LW-08 air search radar 41, 48, 466, 551

M

M2 gun fire-control radar 517
M4/3 Seacat fire-control radar 517
M8/24 fire control 308, 314, 332, 334, 349, 378
M 25 fire-control radar 468
M 45 fire-control radar 468
Manta ESM 295, 426
Mare Tail sonar 472, 476, 615, 619
Mavis ESM 431
MBY-110 combat system 392
MG 311 sonar 619
MGK-335 Platina sonar 623
MicroPUFFS sonar 432, 436
MIDAS mine detection system 248
Mk 34 gun fire control 499, 607, 754
Mk 35 fire-control radar 582
Mk 37 GFCS 668, 671, 674, 682, 685, 685, 689, 693, 704, 708
Mk 51 GFCS 668, 682, 693
Mk 52 Mod 2 gun fire-control system 44
Mk 56 GFCS 697
Mk 63 gun fire-control system 44
Mk 68 gun fire-control system 718, 729
Mk 74 missile fire control 487, 492, 599, 603, 718, 724, 729, 744
Mk 86 gun fire control 487, 493, 501, 724, 738, 744
Mk 91 fire-control system 739
Mk 95 SAM fire-control radar 62, 67, 71, 76
Mk 98 missile fire control 179
Mk 99 FCS 607, 754, 761
Mk 105 torpedo FCS 674
Mk 113 Mod 9 FCS 234
Mk 114 ASW fire control 487, 577, 599, 704, 713, 729
Mk 116 ASW fire control 492, 501, 608, 739, 745, 754
Mk 117 Mod 0/2/3 FCS 237, 241, 247
Mk 118 torpedo fire control 179
MM/BPS-704 radar 366, 369
MM/BSN-716 combat system 365, 368
Model 1A/B fire-control system 570, 599
Model 2-12B weapon control 582, 586, 592
Model 2-21 GFCS 587, 592, 599, 603, 604
Model 76 periscope 275, 329
Monolit missile control 629
Mouse Roar sonar 165, 168, 170, 173, 202, 204, 206, 208, 210, 213, 217, 219, 221
MP 145 radar 629
MPK-50 search radar 392, 395, 397, 399
MSI-90(U) torpedo control 317, 355, 357

N

Najir weapon control 548
NEPDS combat control 417, 420, 423, 426
Nettunel ESM/ECM 30
Nettuno ESM/ECM 17, 556, 562
Nixie AN/SLQ-25 decoy system 17, 29, 62, 67, 71, 75, 487, 491, 498, 510, 563, 592, 595, 607, 718, 737, 744, 753
NOLQ-1 ECM 574, 577, 599, 603
NOLQ-2 ECM 595, 606
NOLR-5 ECM 570
NOLR-6 ESM 582, 586, 591, 599
NOLR-8 ESM 586
NS 9034 ESM/ELINT radar 310
NULKA decoy 717

O

OFS-2D navigation radar 577
OLR 9 combat data system 574, 577, 582, 591, 603
OLT 3 jammer 582, 586, 592, 599
OPS 11 air search radar 571, 574, 577, 582, 600, 604
OPS 14 air search radar 587, 592
OPS 16 search radar 600
OPS 17 search radar 571, 582
OPS 18 search radar 587
OPS 20 navigation radar 596, 608
OPS 24 air search radar 592, 596
OPS 28C/D air search radar 574, 577, 592, 596, 600, 604, 608
OQR 1 TACTASS 582, 587, 592, 596
OQR 2 sonar 608, 608
OQS 3 sonar 571, 574, 582, 600
OQS 4 sonar 587, 592, 604, 608
OQS 5 sonar 596
OQS 101 sonar 577
OQS 102 sonar 608
OUTBOARD II ECM 487, 491, 737
Outfit CXA DF equipment 226
Outfit DCB combat data system 225, 230
Outfit DLB decoy 652
Outfit DLJ(1) ECM 56
Owl Screech fire-control radar 472, 615, 619, 623
OYQ-3 combat data system 577
OYQ-4 combat data system 603
OYQ-5 combat data system 582, 586
OYQ-6 combat data system 592
OYQ-7 combat data system 596
OYU-6 combat data system 574

P

Palm Frond navigation radar 22, 26, 476, 637
Park Lamp DF antennas 165, 167, 170, 172, 175, 202, 206, 208, 210, 212, 215, 216, 219, 220
Pea Stick radar 524
Peel Group fire-control radar 615, 619, 623
Pegas 2M sonar 524
Pelamida towed array 170, 173
Phoenix II ESM 339, 344
Pike Jaw sonar 276, 281, 284, 285
PIRANHA II IR tracker 548
PIRANHA III IR tracker 541
PISCES command system 280
PK-10 decoy system 26, 629, 635
Plate Steer search radar 22, 637
Pop Group fire-control radar 472, 476, 481
Porpoise ESM 331, 349, 352, 437
Prairie Masker 577, 737
PRS 3-15 sonar 331
PSU-83 sonar 308, 320
Punch Bowl weapon control 204, 483

Q

Quad Loop DF antenna 199, 400

R

RAIDS anti-missile system 739
RALW air search radar 551
RAN 12L search radar 30
RAPIDS ESM 381
RCM-2 jammer 664
RDL-127 ESM 664
Rice Lamp fire-control radar 520, 524
Rice Screen air search radar 524
Rim Hat ESM 175, 215, 216, 219
RM 1226 search radar 5
RM 1229 nav/search radar 12
Round House Tacan 472, 483, 629
RS-100 transponder 365, 368
RTN 10X radar 709
RTN 11X missile warning radar 30
Rum Tub ESM 472, 475, 481
RW-23-1 ESM 524

S

S63B radar 349
SACTIS 1 combat system 365
SACTIS 2 combat system 368
SAD missile command data system 160, 163
SADOC 1 tactical data system 462
SADOC 2/IPN 10 tactical data system 47, 557, 563
SADOC 3/IPN 20 tactical data system 18
SADS-TG sonar 248
SAGAIE decoy launcher 4, 11, 535, 547, 563
SARIE ESM 314
SAT weapon control system 160, 163, 196
SATIR Z103B tactical data handling 724
Satnav 285
SCLAR ECM rocket launchers 18, 461, 556, 692
Scylla sonar system 270
SDG-1800 degaussing 272
Sea Gnat IR decoy 753
Sea Sentry Version III ESM 362
Sea Tiger search radar 524
Sealion 307, 319, 354
SENIT 2 tactical data system 5, 536
SENIT 4 tactical data system 541
SENIT 6 tactical data system 548
SENIT 8 tactical data system 11
SEPA Mk 3 FCS 347
SERO 14 periscope 358
SERO 15 periscope 358
SEWACO/Foresee combat data 465
SEWACO VIII combat data 384
SFCS Mk 1 fire control 340, 432, 435
SGR-103 search radar 41
SGR-109 height-finder radar 41
Shark Fin sonar 202
Shark Gill sonar 175, 204, 206, 213, 215, 217, 219
Shark Teeth sonar 165, 168, 170, 173, 199, 208, 210, 221, 392, 404
Shield decoy system 43, 510, 689
Shikari combat data system 551
SHINPADS combat system 511
SICONTA tactical control system 44
Side Globe ECM 472, 475, 481
SIDEKICK ESM 486, 491, 498, 737, 744
SINBADS weapon control 342, 347, 349, 363
SINS navigation system 272
SISDEF torpedo control 437, 646
Skanter search radar 308, 320
Skanter Mil-Par CCA radar 44
Skat 3 sonar 213, 217
Sky Watch air search radar 22, 26
SLASM ASW sonar 529
SLQ 732 radar 556
SLR 4 ESM 461
SMCS-V command system 184
Snoop Group radar 453, 455
Snoop Pair search radar 175, 204, 206, 215, 217, 219
Snoop Plate search radar 276, 278, 280, 281, 284
Snoop Slab search radar 199
Snoop Tray search radar 158, 165, 168, 170, 173, 192, 202, 208, 210, 213, 220, 284, 285, 392, 404, 407
SNW 10 air/surface search radar 517, 639
SPECTRUM sonar/FCS 381
SPG 34 fire-control radar 44, 571
SPG 51C/D missile fire control 488, 493, 548, 564, 604, 719, 719, 745
SPG 55 fire-control radar 462
SPG 60 fire-control radar 488, 745
SPG 70 fire-control radar 462, 641, 709
SPG 74 fire-control radar 19, 462
SPG 75 fire-control radar 19
SPG 76 fire-control radar 558, 564
SPG 501 fire-control radar 512
Spin Trough radar 611
SPN 35 aircraft control radar 30
SPN 64 navigation radar 67, 71, 76
SPN 720 CCA radar 41
SPN 728(V)1 CCA radar 19
SPN 748 navigation radar 558, 564
SPN 749(V)2 navigation radar 19
SPQ 2D search radar 558
SPQ-9A gun fire-control radar 488, 493, 745
SPQ 501 search radar 512
SPQ 502 air search radar 512
SPS 10 search radar 682, 685, 689, 693, 697, 705, 713
SPS 29 air search radar 685, 705, 709
SPS 37 air search radar 682
SPS 40 air search radar 44, 682, 685, 689, 693, 697, 705, 709
SPS 48 LR air search radar 62, 67, 71, 76, 488, 493, 745
SPS 49 LR air search radar 62, 67, 71, 76, 488, 493, 500, 745
SPS 52 air search radar 19, 30, 34, 462, 558, 564, 604
SPS 55 search radar 30, 493, 500, 745
SPS 58 air search radar 705, 713
SPS 64 navigation radar 34, 493, 500, 745
SPS 67 search radar 62, 67, 71, 76, 488, 493, 500
SPS 702 target indicator radar 19, 462, 564
SPS 768 air search radar 19, 462, 558, 564
SPS 774 search radar 19, 558, 564
SPY 1 search radar 500
SQQ 89 sonar 501
SQR-18 sonar 577
SQR 19 TACTAS sonar 501, 746
SQS 23 sonar 67, 462, 682, 685, 710, 713
SQS 29 sonar 682
SQS 35 sonar 571, 577
SQS 53 sonar 501
Square Tie search radar 524
Squid Head ESM 199, 404
SRBOC decoy 29, 62, 67, 71, 75, 487, 492, 499, 519, 574, 582, 586, 591, 595, 599, 603, 606, 717, 723, 729, 737, 753
SRD-19 ESM 43
SS-2 radar 445, 447, 449
SSDE ejector 270
SSDE Mk 2/4 ejectors 431
SSDE Mk 6 decoy launcher 225, 440
SSDE Mk 8 decoy launcher 230
SSE Mk 10 decoy launcher 184
SSTDS decoy system 67, 71, 75
STIR radar 466, 713
Stop Light ESM 199, 202, 404, 407, 453, 455
Strut Curve search radar 611
Strut Pair search radar 22, 26, 630
SUBTASS sonar 436
Sub-TDS combat system 320

SWG-3 Tomahawk control system 738, 761
Syllex decoy 529
System DCC combat system 440

T

T-Mk 6 Fanfare decoy 704, 713, 729
TACTASS sonar 582, 587, 596
Tamir 2 sonar 524
Tamir 5 sonar 278, 279, 281
TAS Mk 23 target acquisition radar 62, 67, 71, 76
TAVITAC combat system 519, 524
TB-16 sonar 248
TB-23 VLF sonar 241
Team Rockwell combat system 271
Tee Plinth weapon control 472, 615, 622
TFCS Mk 106 torpedo control 447, 451
Tilt Pot weapon control 472, 615
Timnex 4CH(V)2 ESM 360
TM 1226 navigation radar 41, 689
Top Dome fire-control radar 472, 476, 481
Top Hat BQR-19 sonar 234
Top Pair search radar 476
Top Plate air search radar 26, 476, 630, 637
Top Steer search radar 476, 637
TQN-2 ECM 551
Trap Door fire-control radar 22
TRITAN command & control system 30
Triton Type 2051 sonar 435
Trivetts-UEC weapon control 305
Trout Cheek sonar 158, 192
TRS 3004 Sea Tiger surveillance radar 519
TRS 3100 surveillance radar 329
TRS 3110 surveillance radar 160, 163
TSM 2225 sonar 270
TSM 2253 sonar 270
TSM 2272 Octopus sonar 385
TSM 2633 sonar 552
Type 162 sonar 647, 654, 660, 665
Type 170 sonar 517
Type 182 decoy 652, 659
Type 184 sonar 51, 517, 647, 664
Type 275 fire-control radar 639
Type 277M/Q height-finder radar 647
Type 343 fire-control radar 524
Type 374G fire-control radar 520, 524
Type 670 ECM 652
Type 675 Guardian ESM 55, 652, 658
Type 901 fire-control radar 647
Type 903 fire-control radar 647
Type 904 fire-control radar 51
Type 909 fire-control radar 653, 664
Type 921-A ESM 158
Type 965 air search radar 647, 664
Type 966 air search radar 51
Type 990 fire-control radar 56, 660
Type 992 search radar 56, 647, 664
Type 994 search radar 51
Type 996 search radar 56, 653, 660
Type 1001 search radar 378
Type 1006 navigation radar 51, 56, 226, 432, 433, 438, 653, 660, 664
Type 1007 navigation radar 56, 184, 231, 270, 303, 318, 340, 355, 358, 441
Type 1022 LR air search radar 56, 653, 660
Type 1226 navigation radar 466
Type 2007 sonar 226, 231, 432, 434, 435, 438, 441
Type 2008 sonar 231
Type 2016 sonar 57, 653, 660
Type 2019 sonar (PARIS) 226, 231
Type 2020 sonar 226, 231
Type 2026 sonar 226, 231, 378, 385, 441
Type 2040 sonar 441
Type 2041 sonar 441
Type 2046 sonar 231, 441
Type 2050 sonar 653, 660
Type 2054 sonar 184
Type 2066 decoy 225, 230, 440
Type 2071 decoy 225, 230, 440
Type 2072 sonar 231
Type 2074 sonar 227, 231
Type 2076 sonar 231
Type 2077 sonar 227, 231
Type 2081 sensors 226
Type 2082 sonar 231

U

UA 4 ECM 433
UA 8/9 ESM 645
UAA-2 ESM 55, 652, 658
UAC ESM 440
UAF(1) ESM 55
UAP(2) ESM 225, 230
UAP(3) ESM 184
ULQ-6 ECM 674, 682, 685, 693, 696, 704, 717
USK 800 DF system 357
UYS 503 sonar processor 513

V

V1-01 height-finder radar 41
VAMPIR IR surveillance 10, 540, 547
VEGA I weapon control 541
VELOX sonat intercept 314
VIGY-105 weapon control 12, 542
VPS 2 Meroka fire control 30

W

W-160 fire-control radar 713
Wasp Head fire-control radar 524
Watch Dog ESM 611, 615
WDS Mk 14 target designator 745
Whale Tongue sonar 637
Wine Flask jammer 481
Wine Glass jammer 628
WJ-1140 ESM 682
WLQ-4 ESM 237, 241
WLR-1 ESM .. 246, 445, 516, 682, 685, 693, 696, 704, 717
WLR-3 ESM 445, 693, 704
WLR-8 ESM 233, 246
WLR-9 ESM 247
WLR-10 ESM 233, 247
WM25 fire-control radar 466, 577
Wolf Paw sonar 615

Z

ZLR 3/5 ESM 372
ZLR 4/6 ESM 372
ZPS-6 search radar 372, 375
ZQQ-4/5 sonar 372, 375
ZQR-1 sonar 372, 375
ZW-01 search radar 41
ZW-03 navigation radar 468
ZW-06 navigation radar 44, 48, 381
ZW-07 navigation radar 384

Aircraft and Weapons Index

2A38M gun 26
4K80 Bazalt SSM 21, 199, 474
4K85 SSM 201

A

A-6E Intruder (Grumman) 63, 77
A 103 Alouette III (Aerospatiale) 42
A184 torpedo 346, 365, 368
A244/S ASW Torpedo 519, 523, 551, 663
AB 204AS (Agusta-Bell) 81, 675
AB 212 (Agusta-Bell) 81, 463, 559, 564, 698
AH-1W Supercobra 209 (Bell) 108
AK-100 100 mm gun 551, 628
AK-130 130 mm/70 gun 628, 634
AK-230 L/65 30 mm gun mounting 618
AK-630 Gatling CIWS 22, 26, 471, 480, 551, 611, 614, 618, 622, 628, 635
AK-726 76.2 mm gun 471, 610, 614, 618, 622
Albatros SAM 555, 561
Alizé (Dassault) 6, 123
Alouette III A 103 (Aerospatiale) 42
AM-1 mine 392, 394, 395, 397, 398
Anakonda W-3UI helicopter 623
AS-61 (SH-3D) (Agusta-Sikorsky) 20, 468
AS 332/AS 532 Cougar (Eurocopter) 85
AS 350/355 Ecureuil (Eurocopter) 45, 87
AS 550/555 Fennec (Eurocopter) 87
AS 565 Panther (Eurocopter) 7, 89, 548
Aspide SAM (Alenia) 17
ASTER 15 anti-missile system (Aerospatiale) 9
AV-8B Harrier II/II Plus (McDonnell Douglas/BAe) 19, 31, 130
AV-8S Harrier VA.1 (BAe/McDonnell Douglas) ... 35, 134

B

B515/ILAS-3 torpedo launchers (Whitehead) 17, 518, 523, 551, 565, 663
Barak-1 SAM 645
Bazalt 4K80 SSM 21, 199, 474
Bell 206 JetRanger (Bell) 108
Bell 209 AH-1W Supercobra (Bell) 108
BGM-109 Tomahawk SSM .. 236, 240, 245, 250, 489, 496, 733, 750, 758
BO-105 (Eurocopter) 90
Bofors 40 mm/70 gun 465, 467, 516, 703, 708, 712
BR 1050 Alizé (Dassault) 6, 123
Breda 40 mm gun mounts 461

C

C-801/802 SSM 192
CADS-N-1 CIWS 26, 628
CAPTOR Mk 60 mine 237, 246, 251
CH-46 Sea Knight (Boeing-Vertol) 110
CH-53E (Sikorsky) 116
CH-124A Sea King (Sikorsky) 513
Compact 40 mm/70 gun mounting (OTOBREDA) . 17, 641
Compact 76 mm/62 gun 586, 591, 595, 670, 703, 708, 712
Compatto 127 mm/54 gun 556, 562, 606
Cougar AS 332/532 (Eurocopter) 85, 647
Crotale EDIR SAM system 4, 518, 522, 527, 539
Crusader F-8(FN) (Ling-Temco-Vought) 6, 145

D

DM1/2A1/2A3 torpedoes 314, 354
DM2A4 torpedo 357

E

E-2C Hawkeye (Northrop Grumman) ... 13, 63, 68, 72, 141
E12 torpedo 298
E14/15 torpedoes 302, 305
EA-6B Prowler (Grumman) 63, 68, 72, 77, 140
Ecureuil AS 350/355 (Eurocopter) 87
EH 101 Merlin (European Helicopters) 92
ES-3A Viking 69, 72, 77
Etendard IVP (Dassault) 6, 124
EUROSAAM VLS launcher 9
Exocet MM 38 SSM 515, 527, 532, 640
Exocet MM 40 SSM 539, 545, 644
Exocet SM 39 torpedo 160, 162, 195, 289
Explorer MD 900 (McDonnell Douglas) 114

F

F2 Type A (M693) cannon (Giat) 9
F-8(FN) Crusader (Ling-Temco-Vought) 145
F-14 Tomcat (Northrop Grumman) 63, 68, 72, 77, 143
F17 Mod 2 torpedo 163, 196, 290, 292, 295
F/A-18C Hornet (McDonnell Douglas) 77, 148
Fennec AS 550/555 (Eurocopter) 87
FG 29 mine 196, 290
'Flanker-D' Su-33 (Sukhoi) 27, 132
FQF-2500 ASW mortars 524

G

GAM/B01 20 mm cannon 55
Gauntlet SA-N-9 SAM 22, 25, 479
Goalkeeper CIWS 55
Goblet SAM 470
Granit P-500 SSM 25, 478
Grissom/CADS-N-1 CIWS 479
Grumble SAM 471, 474, 478

H

Harpoon RGM-84B SSM 485, 497, 580, 584, 590, 597, 601, 605, 680, 687, 691, 721, 727, 733, 742, 750
Harrier II Plus AV-8B (McDonnell Douglas/BAe) 31
Hawkeye E-2C (Northrop Grumman) 13, 63, 68, 72, 77, 141
Hedgehog ASW mortar 670, 681
'Helix'-A/-C-/-D Ka-27/28/32 (Kamov) 23, 27, 52, 96
'Helix-B Ka-29/32 (Kamov) 97
HH-60H Rescue Hawk (Sikorsky) 69, 73
Honeywell 44 torpedo 516, 645
'Hormone' Ka-25 (Kamov) 94
Hornet F/A-18C (McDonnell Douglas) 68, 77, 148
HS.23 Seahawk (Sikorsky) 32
Hsiung Feng 1A SSM 669, 702
Hsiung Feng II SSM 707
HY-2 ASM 522

I

IAR-316B Alouette III 612
Impact 324 mm torpedo (Eurotorp) 17
Intruder A-6E (Grumman) 63, 77
IPqM anti-submarine torpedo 328

J

JetRanger 206 (Bell) 108, 648
JL-1 Ju Lang-1 SLBM 157
JL-2 Ju Lang-2 SLBM 276

K

Ka-25 'Hormone' (Kamov) 94, 476, 483
Ka-27 'Helix' (Kamov) 52, 483, 620, 630
Ka-27/28/32 'Helix'-A/-C-/-D (Kamov) 23, 27, 52, 96
Ka-29/31 'Helix-B (Kamov) 23, 27, 97
Kashtan CIWS 26, 479, 628
Klinok SAM 626
Kynshal SAM 22, 25

L

L3 torpedo 302
L5 Mod 3/4 torpedo 160, 163, 195, 290, 295, 300, 305, 528, 533, 540, 546
L/38 127 mm Mk 30 gun mounting 667, 670, 673, 681, 684
L/38 127 mm Mk 38 gun mounting 688, 692, 695, 703, 708
L/50 76 mm gun mounting 570, 696
L/53 152 mm gun mounting 465, 467
L/54 127 mm gun mounting 486, 491, 498
L/58 130 mm gun mounting 523
L/60 40 mm gun mounting 667, 681
L/60 57 mm gun mounting 467
L/65 30 mm gun mounting 618
L/70 40 mm gun mounting 47
L/70 100 mm gun mounting 22, 480
L/70 130 mm gun mounting 475, 480
Lynx (Westland) 101
Lynx Mk 4 FN (Westland) 530, 543
Lynx HMA Mk 8 (Westland) 103, 654, 660

M

M-1 Volnya SAM 614, 617, 621
M2HB 12.7 mm machine gun 703, 708, 712, 717
M4/TN70 MSBS 162
M-22 Uragan SAM 550
M45/TN75 MSBS 160
MALAFON ASW missile 533
MASURCA SAM 532
Matador VA.1 (BAe/McDonnell Douglas) 35, 134
Mauser 30 gun 540
MBB Bö-105CB (Eurocopter) 686
MD 500 (McDonnell Douglas) 113, 705, 710, 713
MD 900 Explorer (McDonnell Douglas) 114
Merlin EH 101 (European Helicopters) 92
Meroka CIWS 29
MH-53E (Sikorsky) 114
MILAS ASW missile 561
Mk 24 Tigerfish torpedo 183, 225, 230, 274, 328, 350, 433, 439
Mk 30 L/38 127 mm gun mounting 667, 670, 673, 681, 684
Mk 38 L/38 127 mm gun mounting 688, 692, 695, 703, 708
Mk 37 torpedo 326, 352, 387, 433, 447, 449, 451
Mk 41 GMVLS 34, 509, 759
Mk 42 127 mm/54 gun mounting 573, 577, 581, 599, 602, 716, 723, 728
Mk 45 Mod 0/1 127 mm L/54 gun mounting 736, 743, 752, 760
Mk 46 Mod 2 torpedo 723
Mk 46 Mod 5/7 torpedo .. 75, 460, 486, 491, 498, 509, 556, 570, 573, 577, 581, 586, 599, 602, 606, 670, 680, 684, 688, 692, 695, 703, 708, 712, 716, 728, 736, 743, 752, 760
Mk 48 Mod 4 torpedo 269, 360, 384, 431, 435
Mk 48 ADCAP torpedo 179, 233, 237, 241, 246, 250
Mk 50 torpedo 491, 498, 736, 743, 752, 760
Mk 57 SAM 61, 66, 70, 75
Mk 60 CAPTOR mine 237, 246, 251
Mk 67 SLMM mine 237, 246, 251
Mle 1953 100 mm automatic gun 4
Mle 1968 100 mm/55 CADAM gun 530, 533, 540, 546
MM 38 Exocet SSM 515, 527, 532, 539, 640, 662
MM 40 Exocet SSM 539, 545
MMI 76 mm/62 gun 460
Moskit P-270 SSM 550, 626, 633

N

NAS 332SC Cougar (Nurtanio Eurocopter) 647
NT 37E/F torpedo 280, 309, 317, 384

O

Ocean Hawk SH-60F 64, 69, 72, 77
Oerlikon 20 mm cannon 528, 540, 546, 645, 651, 658, 664
Oerlikon 35 mm GDM-C gun mounting 692, 696
Osprey V-22 (Bell/Boeing) 105
Otomat Mk 2 SSM launcher 464

P

P-21 Rubezh SSM 610, 614, 621
P-22 Rubezh SSM 617
P-35 SSM 21
P-270 Moskit SSM 550, 626, 633
P-500 Granit SSM 25
Panther AS 565 (Eurocopter) 7, 89
Phalanx Mk 15 Vulcan CIWS 55, 61, 66, 70, 75, 486, 491, 498, 510, 573, 577, 582, 586, 591, 595, 599, 603, 606, 652, 658, 712, 717, 736, 743, 752, 760
Polaris A1 SLBM 180
Poseidon C3 SLBM 180
Prowler EA-6B (Grumman) 63, 68, 72, 77, 140

R

Rafale M (Dassault) 13, 128
RIM-7RTC SAM 759
RIM-72C Sea Chaparral SAM 669, 702, 708
RIM-116A RAM 722, 734
RIM-156A SAM 759
RBU-1000 ASW mortar 471, 481, 614
RBU-6000 ASW mortar 471, 475, 481, 610, 614, 618, 622, 628, 635
RBU-12000 ASW mortar 22, 26, 481

RGM-84B Harpoon ASM 485, 497, 580, 584, 590, 597, 601, 605, 680, 687, 691, 721, 727, 733, 742, 750
RSM-40 Vysota SLBM 165, 167
RSM-50 Volna SLBM 169
RSM-52 SLBM 174
RSM-54 Shetal SLBM 172
Rubezh P-21/22 SSM 610, 614, 617, 621
RUM-139 ASROC 751, 759
RUR-5A ASROC .. 570, 572, 576, 580, 585, 590, 595, 598, 601, 606, 680, 684, 687, 691, 695, 702, 711, 722, 728, 735

S

S-2 Tracker (Northrop Grumman) 41, 45, 138
S-3 Viking (Lockheed) 69, 72, 77, 146
SA 319B Alouette III helicopter 665
SA-N-1 Goa SAM 614, 617
SA-N-3 SAM 470
SA-N-4 SAM 471, 474, 479
SA-N-5/-8 SAM 391, 394, 395, 397, 398, 638
SA-N-6 SAM 471, 474, 478
SA-N-7 SAM 550, 634
SA-N-8 SAM 175
SA-N-9 Gauntlet SAM 22, 25, 479
SA-N-11 missile system 26, 479
SA-N-12 SAM 634
SA 321G Super Frelon (Eurocopter) 13, 84
SADRAL missile system 4, 9, 43, 540, 546
SAET-60 torpedo 276, 277, 279, 281, 282, 283, 285, 406, 408, 409
SAK 40L/70 gun (Bofors) 40, 685
Sandbox SS-N-12 SSM 21, 199, 474
Sawfly SS-N-8 SLBM 165, 167
Seacat GWS.22 SAM 50, 516
Sea Chaparral SAM 669, 702, 708
Sea Dart SAM (BAe) 55, 650, 656, 663
Sea Harrier FA.2 (BAe) 57, 136
Sea Harrier FRS Mk 51 (BAe) 48, 51, 135
Seahawk S-70B/SH-60B (Sikorsky) 32, 740, 746, 762
Sea King (Westland) 48, 51, 99, 552
Sea King AEW (Westland) 58
Sea King HAS 6 (Westland) 58
Sea King SH-3H (Sikorsky) 31, 41
Sea Knight CH-46 (Boeing-Vertol) 110
Sea Slug Mk 2 SAM 644
Sea Sparrow SAM 572, 576, 580, 590, 594, 734, 759
Sea Vulcan 20 mm gun 681
Seeaal/Seehecht/Seeschlange torpedoes 314, 354
Seehake torpedo 357
Seersucker ASM 522
SET-65E torpedo 157, 192, 406, 408, 409, 453
SH-2G Super Seasprite (Kaman) 111, 503
SH-3 Sea King (Agusta/Sikorsky) 20, 45, 83
SH-3 Sea King (Sikorsky) 31, 41, 115
SH-60B/J Seahawk (Sikorsky) 32, 119, 503, 574, 578, 587, 591, 596, 740, 746, 762
SH-60F Ocean Hawk (Sikorsky) 64, 69, 72, 77
Shetal RSM-54 SLBM 172
Shipwreck SS-N-19 SSM 25, 203
SM-1ER SAM 459
SM-1MR SAM 545, 554, 562, 598, 601, 673, 711, 716, 722, 727
SM-2ER SAM 759
SM-2MR SAM 485, 490, 509, 605, 743, 751
SM 39 Exocet cruise missile 160, 162, 195, 289
Spearfish torpedo 183, 224, 230
Squid ASW mortar 516
SS-CX-5 Sapless cruise missile 222
SS-N-2 Styx SSM 610, 614, 621
SS-N-8 Sawfly SLBM 165, 167
SS-N-9 Siren SSM 201
SS-N-12 Sandbox (P-35) SSM 21, 199, 474
SS-N-14 Silex ASW torpedo 471, 479, 627
SS-N-15 Starfish ASW system 172, 174, 201, 204, 210, 212, 214, 216, 218, 222, 403, 480, 627
SS-N-16 Stallion ASW system 174, 201, 204, 210, 212, 214, 216, 218, 222
SS-N-18 SLBM 169
SS-N-19 Shipwreck SSM 25, 203, 478
SS-N-20 Sturgeon SLBM 174
SS-N-21 Sampson cruise missile ... 212, 214, 216, 218, 220
SS-N-22 Sunburn SSM 550, 626, 633
SS-N-23 Skiff SLBM 172
SST 4 torpedo 325, 348, 352, 362
Sting Ray ASW 657
Stonefish mine 293, 300
Strela/Igla-M SAM 391, 394, 395, 397, 398, 638
STWS Mk 2 ASW torpedo 651, 656
Su-33 'Flanker-D' (Sukhoi) 132
Sub-Harpoon UGM-84B SSM 224, 229, 237, 240, 250, 269, 280, 292, 300, 309, 336, 350, 360, 372, 374, 383, 431, 439
Super Etendard Modernisé (Dassault) 6, 125
Super Frelon SA 321G (Eurocopter) 13, 84
Super Lynx (Westland) 103, 682
Super Puma UH-14 (Aerospatiale) 45
Super Rapid 76 mm /62 gun 510, 556, 562
Super Seasprite SH-2G (Kaman) 111, 503
Supercobra 209 AH-1W (Bell) 108
SUT torpedo 300, 330, 332, 334, 337, 339, 342, 344, 380, 437, 445

T

Teseo Mk 2 SSM (OTOBREDA) 16, 459, 554, 560
TEST-71ME torpedo 391, 394, 395, 397, 398, 400, 401, 455
Tigerfish Mk 24 torpedo 183, 225, 230, 274, 328, 350, 433, 439
Tomahawk BGM-109 SSM .. 236, 240, 245, 250, 489, 491, 733, 750, 758
Tomcat F-14 (Northrop Grumman) 63, 68, 72, 77, 143
Tp 61 torpedo 307, 317, 319
Torpedo 2000 425
Tracker S-2 (Northrop Grumman) 41, 45, 138
Trident I (C4) UGM-96 SLBM 178, 180
Trident II (D5) UGM-133 SLBM 178, 180, 183
Twin 100 mm/56 guns 519
Type 43X2 torpedo 425
Type 53-51 torpedo 192
Type 53-56 torpedo 406, 408
Type 53-65 torpedo 208, 400, 401
Type 61 23 mm/63 cannon 524, 688
Type 71 ASW rocket 570, 582
Type 76 37 mm/63 gun 519
Type 87 SSM 594
Type 89 torpedo 372, 375
Type 431 torpedo 416, 419, 423
Type 613 torpedo 416, 419, 422

U

UGM-84B Sub-Harpoon SSM 224, 229, 237, 240, 250, 269, 280, 292, 300, 309, 336, 350, 360, 372, 374, 383, 431, 439
UGM-96 SLBM 178
UGM-133 SLBM 178, 183
UH-1N (Bell) 81
UH-12 Esquilo AS 350 (Eurocopter) 45
UH14 Super Puma (Aerospatiale) 45
Uragan M-22 SAM 550

V

V-22 Osprey (Bell/Boeing) 105
VA.1 Matador (BAe/McDonnell Douglas) 35, 134
Vickers 102 mm/60 gun 516
Vickers 114 mm Mk 5/6/8 gun 638, 641, 645, 651, 657, 663
Viking S-3 (Lockheed) 69, 72, 77, 146
Volna RSM-50 SLBM 169
Vulcan Phalanx Mk 15 CIWS 55, 61, 66, 70, 75
Vysota RSM-40 SLBM 165, 167

W

Wasp HAS Mk 1 (Westland) 98
W-3UI Anakonda helicopter 623
W-11-M gun mounting 638

Y

YJ-1/2 Ying Ji SSM 192, 283, 518, 522

Z

Z-9A Haitun helicopter 520, 525
ZSU-23-2 cannon 673

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